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PRIMARY REPAIR OF BENIGN STRICTURES OF THE BILE DUCT

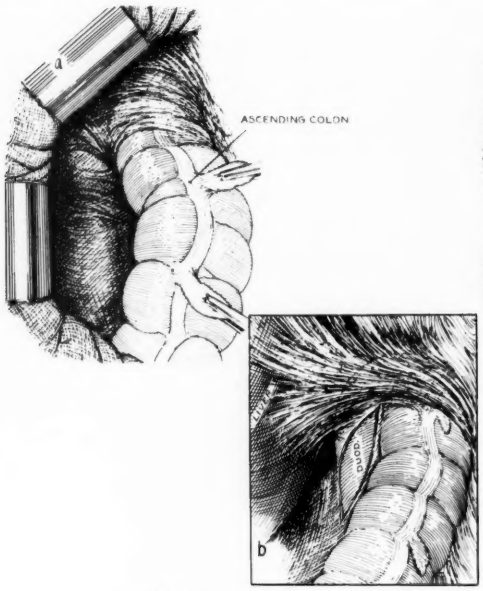
RICHARD B. CATTELL, M.D., F.A.C.S., and JOHN W. BRAASCH, M.D.,
Boston, Massachusetts

FROM 1919 TO MAY 1958, 690 patients with benign biliary stricture have been treated at the Lahey Clinic, with 1,006 operative procedures. Our earlier experiences have been reported by Lahey and Pyrtek and Cattell (2). From this series, a group of 501 patients first seen between the years 1940 and 1955 inclusive has been selected for closer scrutiny. We have reported elsewhere (4) on the general management and current status of these patients, and shall now consider the indications for and the results of primary one stage repair. A total of 447 primary repairs of biliary stricture has been performed in this group of 501 patients. These primary repairs include 207 end-to-end anastomoses of the duct, 142 hepaticojejunostomies, 15 hepaticoduodenostomies, 46 plastic procedures, and 37 dilatations of ductal strictures. Our results with the use of staged operative procedures and with those patients who required unusual types of operative repairs will be described (5, 6).

CHOICE OF OPERATION AND TECHNIQUE

Our operative approach to the problem of biliary stricture is the same as that used for all secondary operations on the biliary tract. A long, right upper rectus muscle-splitting incision is used. The peritoneum is opened first at the inferior portion of this incision, since this is the area least likely to be involved with postoperative adhesions. The hepatic flexure of the colon is almost invariably adherent to the under surface of the liver, and the adhesions in this region must be severed and the flexure dropped (Fig. 1). After this procedure the sweep of the duodenum is located (Fig. 2), and the second and third portions are elevated from below upward until the spermatic or ovarian vein, inferior vena cava, and aorta can be visualized from the patient's right to left. The stomach is then freed from its frequent attachment to the under surface of the liver, and the dissection is completed between the pylorus and second portion of the duodenum, thereby rolling back the anterior part of the first and second portions of the duodenum which are usually adherent to the porta hepatis. Frequently, this area is the site of a fistula from the upper end of the duct to the duodenum. If a fistula is present, disengaging it is delayed until it becomes necessary to do so to find the lower portion of the duct.

From the Department of Surgery, The Lahey Clinic.



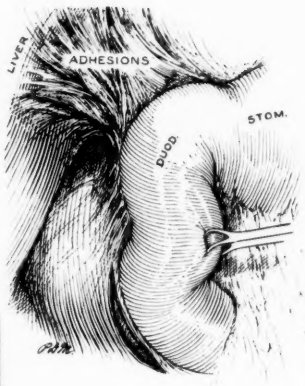


FIG. 1. FIG. 2.

FIG. 1. Release of attachments of hepatic flexure to liver.
FIG. 2. Elevation of duodenum and head of pancreas.

If the subphrenic space is opened previous to or during the course of this dissection, this space and the subhepatic space must be protected by moist gauze pads placed so as to prevent the accumulation of blood and secretions within these areas.

In some cases, the patient's condition is so critical that only hepaticostomy with the production of an external biliary fistula can safely be carried out. In such instances, we then proceed immediately with the dissection of the hilus of the liver to provide external tube drainage. We have usually employed this procedure when liver function is severely depressed, when the results of flocculation and turbidity tests are high, when the serum bilirubin level is very high (above 30 mgm. per 100 c.c.) and in the presence of portal hypertension. This procedure is also useful when severe hepatomegaly interferes technically with the anastomosis, or when the presence of a subhepatic abscess makes the use of an anastomosis unwise. Customarily as large a catheter as possible is secured within the common hepatic duct or within the right or left hepatic ducts separately. Our results with this two stage operation will be reported later (5).

If anastomotic repair of the biliary stricture is contemplated, and if in the past the lower end of the bile duct has not been found, a search is then made for what we call the common duct gland. This is a large lymph node (Fig. 3), often about 2 centimeters in diameter, which lies on the posteroinferior aspect of the gastrohepatic ligament and serves as an accurate guide to the lower end of the common duct. The lower end of the common bile duct is almost always located superior and medial to this gland in the anterior aspect of the gastrohepatic ligament. A core of tissue is then dissected out of the hepaticoduodenal ligament anterior to the common duct node and sectioned vertically until a lumen is found. Probes and scoops must then be inserted into the distal end of the duct and into the duodenum to ascertain that no calculi or

other forms of obstruction are present. Then, a catheter of moderate size is inserted temporarily through the duct and into the duodenum.

Attention is next directed to the hilus of the liver to locate the upper end of the common hepatic duct. Orientation for this dissection is afforded by the location of the hepatic artery, since the duct is usually found anterior and lateral to this pulsating vessel. In some instances the duct is evident because of a bulge in the hilus of the liver at this location. Should extensive dissection be necessary, it is usually advisable to accomplish this within the substance of the liver. The capsule of the liver is incised with a knife, and dissection proceeds within the liver capsule. This dissection may be accomplished with the electrosurgical unit (Fig. 4). If the upper ducts cannot be readily found, they can sometimes be located by needling the hilus of the liver for either white or normal bile. After the lumen of the upper ducts has been encountered and opened, probes and scoops should be passed into the common and right and left hepatic ducts to establish their patency and freedom from calculi. Further dissection can then be accomplished (most readily on the anterior and lateral aspects of the ducts) to outline these ducts more discretely, with probes and scoops defining their course (Fig. 5). The ends of both the upper and lower ducts must be free of neuromatous or excessive scar tissue before suture is attempted. We believe that regrowth of neuromatous tissue is a factor in stricture recurrence.

At this stage of the procedure, a decision must be made regarding the type of repair to be used. We differ from Walters, who favors hepaticoduodenostomy, and Cole and Allen, who use hepaticojejunostomy; our procedure of choice is end-to-end anastomosis of the two ends of the bile duct (Fig. 6). This anastomosis is made over some type of prosthesis by using 5 or 6 interrupted sutures of fine chromic catgut placed through all layers of tissue. To accomplish this satisfactorily, mobility of the duodenum, head of

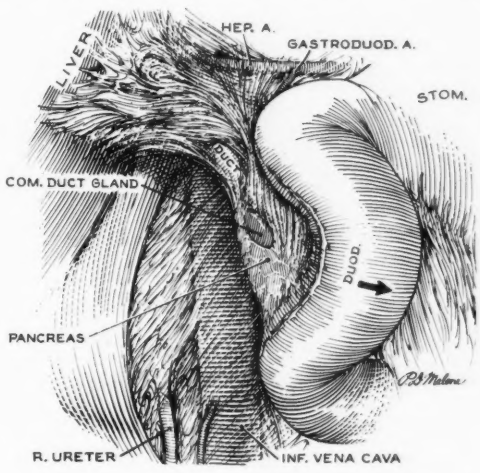


FIG. 3. Location of common duct gland.

the pancreas, and lower end of the duct is necessary so that there is no tension on the suture line. If the lower end of the duct is not suitable because of a great discrepancy in size between the two ends of the duct, if the lower end of the duct is much too short for satisfactory anastomosis, or if the tissues of the upper end of the duct are not suitable for anastomosis, we prefer to carry out hepaticojejunostomy (Fig. 7). With this procedure a long loop of upper jejunum is selected and brought anterior to the omentum and transverse colon. A one layer chromic catgut anastomosis is then completed, usually requiring 6 sutures through all layers. This anastomosis is also made over some type of prosthesis. We have not thought it necessary to construct a Roux-Y limb of jejunum for this anastomosis; rather, for defunctionalization, an enteroenterostomy is made between the afferent and efferent loops of jejunum approximately 6 to 8 inches below the biliary anastomosis. Hepaticoduodenostomy has been used most frequently in patients who have previously undergone gastrectomy, thus sidetracking the duodenum.

Stricture of the bile duct is occasionally evident only as a narrowing of the duct. If this narrowing is high (just at, or immedi-

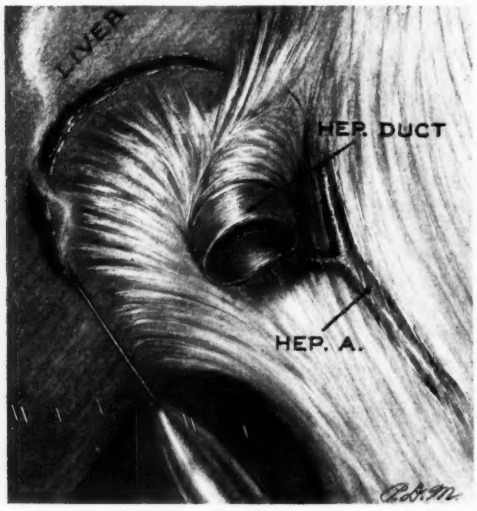


FIG. 4.

FIG. 5.

FIG. 4. Initial dissection at the hilus of the liver is illustrated.

FIG. 5. Dissection of liver hilus with probe defining duct.

ately below, the bifurcation of the common hepatic duct into the right and left hepatic ducts), dilatation is the procedure of choice —especially if either the right or left hepatic duct is involved in the stricturing process. When this type of stricture occurs in the middle or the lower end of the ductal system, end-to-end anastomosis is the procedure of choice. Dilatation or a plastic procedure will occasionally be useful in dealing with minor strictures situated relatively low in the ductal system. The plastic procedure (Fig. 8) consists of horizontal closure of a vertical incision in the duct.

Our best results have followed the use of some type of prosthesis within the anastomosis. We have found no evidence that this practice is harmful and causes stricturing of these anastomoses. If the stricture is located so that a length of 1 centimeter or more of the common hepatic duct is available for anastomosis, a T tube is used, the vertical limb of which is brought out of the duct either above or below the anastomosis. In the case of hepaticojejunostomy, the vertical limb of the T tube is brought out either through the duct above the anastomosis or through the jejunal loop below (Fig. 9). If possible, the former method is preferred. If the use of a T tube is not feasible, straight tubes are utilized and secured within the anastomosis by a single silk stitch.

Several unique situations may be encountered in the repair of biliary strictures that require the use of other surgical procedures and prostheses. In the repair of very high strictures—that is, those involving the common hepatic duct within 1 centimeter of its bifurcation—an indwelling Y-shaped rubber tube is often used as a splint for the anastomosis. These rubber Y tubes can be employed after end-to-end repair, hepaticojejunostomy, plastic repair, or dilatation of these high strictures. This situation will be discussed in detail in another communication (5). The tube is impregnated with 20 per cent barium so that it can be visualized postoperatively on the roentgenogram of

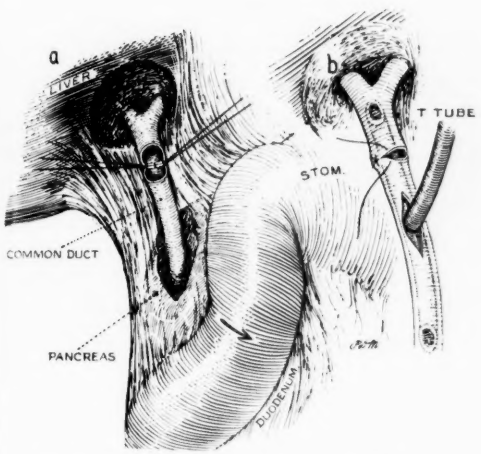


FIG. 6. End-to-end repair of stricture over T tube.

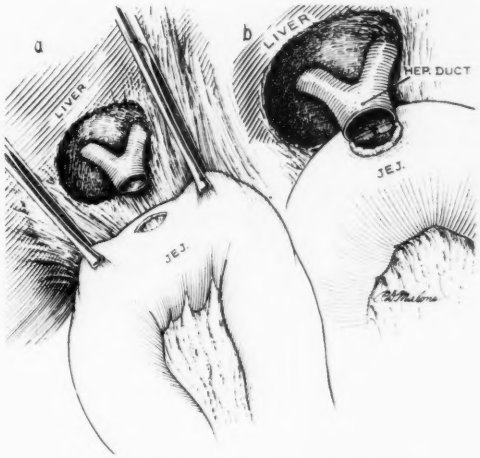


FIG. 7. Technique of hepaticojejunostomy.

the abdomen. This feature is convenient in planning any subsequent operative procedures if symptoms recur. These tubes do not tend to pass spontaneously and, in time, often become plugged with biliary detritus so that another surgical procedure is necessary for their removal. We consider these repairs as being two stage in type. Despite this disadvantage, the use of these tubes is lifesaving when the stricture is very high or the walls of the ducts to be used for the anastomosis are friable.

In some instances the junction of the right and left hepatic ducts has been destroyed, and only the left or the right hepatic duct, or both, are available for anastomosis. Under these circumstances, the ducts can either be anastomosed separately to a loop of jejunum with the appropriate prosthesis within each anastomosis, or they can be joined together by suture and a new septum formed and partially severed—thus creating a new common hepatic duct for anastomosis. In such instances it is usually advisable to employ an indwelling Y tube as a prosthesis.

Under certain circumstances in the past, we have advocated the use of vitallium tubes as prostheses but have discontinued this practice. We have had only a limited experience with the use of the Longmire procedure, as it was found that in most cases the bile ducts at the hilus of the liver can be located and dealt with (790 instances in 802 procedures). When high strictures involving the bifurcation are present, an anastomosis to only the left duct (as in the Longmire procedure) would not afford relief of obstruction to the great mass of liver tissue found in the right lobe. The use of dilatation or anastomosis of biliary sinuses and insertion of tubes into internal biliary fistulas or biliary sinuses have been discontinued because of the poor results that followed these procedures.

RESULTS

The results 3 or more years after primary repair of biliary stricture are depicted in Table I. We believe that strictures are unlikely to recur after this period of time. Of those patients reporting a satisfactory result 3 years after operation, only 4 per cent subsequently noted return of symptoms of the disorder.

The majority of the patients with satisfactory results have experienced no symptoms referable to the biliary tract. The others (5 to 10 per cent) have only infrequent, mild symptoms of obstruction.

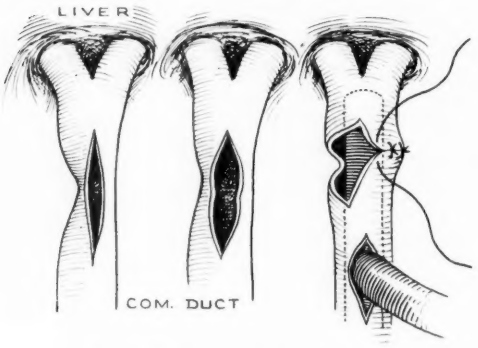


FIG. 8. Technique of plastic repair.

End-to-end repair has been used most frequently (207 operations), with a postoperative mortality of approximately 2 per cent. Four per cent of these patients died subsequently of causes related to the disease. Obstruction recurred in 42 per cent, and 51 per cent were well with a satisfactory result for 3 or more years after operation. The mortality following other types of repair was approximately 4 to 5 per cent. Two to 13 per cent of patients who submitted to other types of primary repair died subsequently as a result of the complications of biliary obstruction. The best results were obtained after plastic procedures for minimal narrowing of the duct. The result was satisfactory after 1 operation in 68 per cent of these patients. Dilatation of the stricture was also usually carried out when strictures were of minimal degree. Fifty-four per cent of these patients obtained a satisfactory result after 1 dilatation. Hepaticojejunostomy was followed by a satisfactory result in 43 per cent, and of a small number of patients subjected to hepaticoduodenostomy (15 patients), about 50 per cent obtained a satisfactory result. Table II shows the results in a recent group of patients in whom an end-to-end repair was carried out. Following these 135 operations, approximately 60 per cent obtained a satisfactory result for 3 years or more.

TABLE I.—BENIGN BILIARY STRICTURE RESULTS 3 OR MORE YEARS AFTER 447 PRIMARY REPAIRS

			Results			
			Dead		Alive†	
Procedure	*Operations, No.*	*Inadequate follow-up,* No.*	*After operation, per cent*	*Of disease, per cent*	*Poor, per cent*	*Satisfactory, per cent*
End-to-end	207	15	2	4	42	51
Hepaticojejunostomy	142	21	5	5	45	43
Hepaticoduodenostomy	15	1	0	13	36	50
Plastic	46	2	4	2	25	68
Dilatation	37	2	5	11	29	54
Total	447					

*The majority (30 of 41) had satisfactory results, but operation was performed less than 3 years previously.
†Excluding those with inadequate follow-up.

The causes of the postoperative deaths and complications, and the prevention and management of these untoward events, were reported for the entire group of 501 patients in another communication (4). The majority of these sequelae are related to the disturbances in liver function frequently seen in these patients; of 39 postoperative deaths, more than half were related to liver failure with or without exsanguinating hemorrhage. Of the 102 major nonfatal complications which followed 802 operative procedures, hemorrhage occurred in 19 and infection in 51 instances.

DISCUSSION

Our procedure of choice for the primary repair of biliary stricture is end-to-end anastomosis of the two ends of the duct. No difficulty has been experienced in finding the lower end of the duct by the recognition in sequence of various anatomic landmarks leading to this structure. Perhaps the most important of these is a lymph node which lies posterior and inferior to the lower segment of the duct. This node is always present in this location and may be readily demonstrated after proper elevation of the second and third portions of the duodenum and the head of the pancreas. The use of the lower end of the duct for anastomotic purposes allows the sphincter of Oddi to remain in functional continuity in the extrahepatic biliary system. Our best results in a com-

parable series of major biliary strictures have followed the use of end-to-end repair, as reported elsewhere (3).

As our technique has improved with experience (Table II), we expect satisfactory results in approximately 60 per cent of the cases following end-to-end repair, with a 2 per cent operative mortality. Close observation of the patient and prompt reoperation following possible recurrence probably could save the majority of patients who die postoperatively of complications connected with biliary cirrhosis. Furthermore, the operative mortality can be appreciably reduced if partial biliary obstruction is not allowed to continue for any length of time without treatment. With decrease in liver function, these patients become subject to postoperative liver failure, hemorrhage, and the hepatorenal syndrome.

Our present technique for anastomosis, be it end-to-end or hepaticojejunostomy, involves the use of 5 or 6 chromic catgut sutures placed in an interrupted fashion through all layers of the duct or jejunum. We prefer catgut since the use of this material is less likely to be followed by subsequent fibrosis and recurrence of the stricture. For this same reason, we use only 5 or 6 sutures placed through all layers rather than a two layer watertight anastomosis.

In our opinion, the use of some type of prosthesis within the anastomosis is beneficial. We have never observed any evidence which would indicate that an inlying rubber tube tends to promote the recurrence of biliary stricture. In fact, in 6 cases in this series, T tubes became inadvertently dislodged in the postoperative period. All 6 of these patients suffered a prompt recurrence of the bile duct stricture.

The site of emergence of the vertical limb of the T tube is important. These limbs should not be brought out at the point of anastomosis, but rather should emerge from the duct either above or below the anastomosis in the case of end-to-end repair, or above or through the jejunum in cases of hepaticojejunostomy. Our worst experience

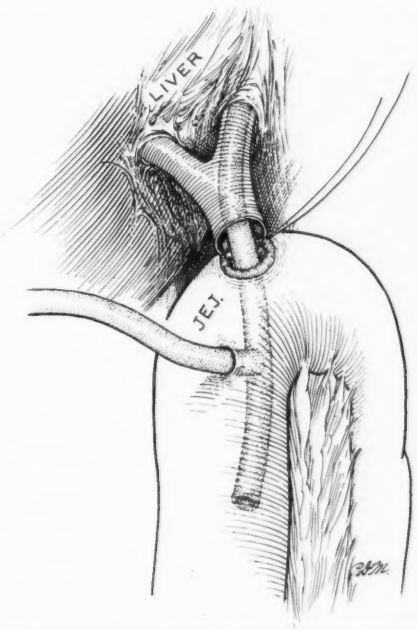


FIG. 9. Hepaticojejunostomy over T tube. The vertical limb is brought out through the jejunum.

in this series of cases has followed the use of a T tube brought out through the anastomosis. In this group of patients, a satisfactory result has been obtained in only 20 per cent.

It is important to defunctionalize the limb of jejunum used in hepaticojejunostomy. We do not consider a Roux-Y limb necessary for this defunctionalization but prefer the use of side-to-side anastomoses involving the afferent and efferent loops of jejunum; these anastomoses are constructed approximately 6 inches from the biliary anastomosis.

TABLE II.—BENIGN BILIARY STRICTURE RESULTS 3 OR MORE YEARS AFTER END-TO-END REPAIR, 1950 1955

		Results			
		Dead		Alive†	
Operations, No.	*Inadequate follow-up,* No.*	*After operation, per cent*	*Of disease, per cent*	*Poor, per cent*	*Satisfactory, per cent*
135	11	2	2	38	57

*The majority (7 of 11) had satisfactory results but operation was performed less than 3 years previously.
†Excluding those with inadequate follow-up.

Within recent years, the number of biliary strictures which are suitable for plastic repair or dilatation has decreased markedly. As mentioned earlier, we use these types of operations only for strictures of minimal degree. It is a great temptation to carry out dilatation only for a stricture in the mid or lower part of the common bile duct and to insert a tube through the strictured area following this dilatation. If the lumen through the strictured area which has been dilated was originally 2 millimeters or less, this type of procedure is not advisable; rather, we recommend that an end-to-end repair or hepaticojejunostomy be employed.

Our experience with hepaticoduodenostomy has been limited and we feel unqualified to comment upon our results with this procedure. In recent years, we have employed this type of repair, usually in those patients who have previously undergone gastric resection with defunctionalization of the duodenum.

SUMMARY

We have reported the indications for and the results following the use of primary repair for benign biliary stricture. These cases were taken from a series of 501 patients first seen at the Lahey Clinic during the years 1940 to 1955 inclusive; 802 operations were carried out in this group. These procedures included 207 end-to-end repairs, 142 hepaticojejunostomies, 46 plastic procedures, 37 dilatations of the stricture, and 15 hepaticoduodenostomies. The postoperative mortality rate ranges from 2 to 5 per cent, and a satisfactory result was obtained in 43 to 68 per cent of patients 3 years or more after operation. Our procedure of choice for benign biliary stricture is end-to-end repair with anastomosis of the two ends of the bile duct. Ideally, this procedure should be accomplished over an inlying T tube, the vertical limb of which is brought out either above or below the anastomosis.

REFERENCES

1. Allen, A. W. Method of re-establishing continuity between bile ducts and gastro-intestinal tract. Ann. Surg., 1945, 121: 412–424.
2. Cattell, R. B. Benign strictures of the biliary ducts. J. Am. M. Ass., 1947, 134: 235–239.
3. Cattell, R. B., and Braasch, J. W. End-to-End Repair of Bile Duct Strictures; Current Surgical Management. Philadelphia: W. B. Saunders Co., in press.
4. Idem. General considerations in the management of benign strictures of the bile duct. N. England J. M., in press.
5. Idem. Two-stage repairs of benign strictures of the bile duct. Surg. Gyn. Obst., in press.
6. Idem. Repair of benign strictures of the bile duct involving both or single hepatic ducts. Surg. Gyn. Obst., in press.
7. Cole, W. H., Reynolds, J. T., and Ireneus, C., Jr. Strictures of common duct. Ann. Surg., 1948, 128: 332–347.
8. Lahey, F. H., and Pyrtek, L. J. Experience with the operative management of 280 strictures of the bile ducts, with a description of a new method and a complete follow-up study of the end results in 229 of the cases. Surg. Gyn. Obst., 1950, 91: 25–56.
9. Longmire, W. P., Jr., and Sanford, M. C. Intrahepatic cholangiojejunostomy for biliary obstruction —further studies; report of 4 cases. Ann. Surg., 1949, 130: 455–460.
10. Walters, W., and Kelly, A. H. Surgical treatment of stricture of common and hepatic bile ducts; 28-year survey. Arch. Surg., 1953, 66: 417–422.

CONTRASTS BETWEEN HUMAN AND EXPERIMENTAL MELANOMAS

DAVID L. KINSEY, M.D., and ROBERT R. SMITH, M.D., Bethesda, Maryland

MALIGNANT MELANOMA, one of the least curable of all tumors occurring in man, remains a perplexing problem to the surgeon because of local recurrence and especially early dissemination. Melanoma comprises about 1.3 per cent of all cancers in all age groups with an incidence of 2.2 per 100,000 male population and 2.6 per 100,000 female population. About 80 to 90 per cent of the melanomas arise in the skin; and in the North, one-fourth of these skin melanomas arise about the head and neck, while one-third arise in this area in the South.

Surgical excision remains the only definitive therapy. Radical surgery has failed to change survival statistics significantly, with reported salvage rates being between 8 and 36 per cent in melanomas of the head and neck.

Malignant melanoma is also seen in laboratory and domesticated animals. Cotchin relates in his book *Neoplasms of Domesticated Mammals* that melanotic tumors appear in the horse (especially gray horses), mule, ox, sheep, pig, and dog. All tend to run a more benign course than their human counterpart, in that regional node and widespread metastases appear later in the course of the disease. Transplantable mouse melanomas have been used for years in laboratory studies of the biologic behavior of cancer. The comparison of these neoplasms with human melanomas is inviting.

In this report the clinical course of a group of patients with malignant melanoma is described, and the problems involved in work with an experimental animal melanoma are outlined.

From the Surgery Branch of the National Cancer Institute, National Institutes of Health, Public Health Service, U. S. Department of Health, Education, and Welfare, Bethesda, Maryland.

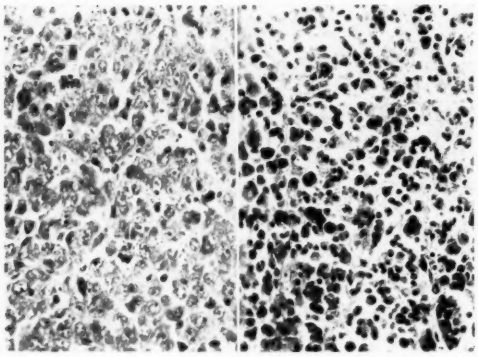
CLINICAL DATA

Twenty-eight white patients presenting malignant melanomas which had originated in the head and neck have been admitted to the National Cancer Institute. The age range of these patients was 16 to 78 years with a mean age of 48 years. The sex distribution was nearly equal, 15 males and 13 females. Eight patients were admitted with disease confined to the head and neck while the remaining 20 patients had systemic dissemination of the cancer when first seen at this institution.

Evaluation of the initial treatment given to the 20 patients admitted with disseminated disease disclosed the fact that local surgical excision, electrodesiccation, or local excision with single node excision was performed in 13 patients, in 12 of whom local recurrence of the primary tumor eventually developed. In 3 of 7 patients treated by either local excision and graft or by en bloc dissection, recurrent tumor developed in the primary site. Thus of the 20 patients admitted with disseminated disease, 15 (75 per cent) had histologically proved local recurrence of the melanoma. In 14 (70 per cent) regional node metastases also developed sometime during the course of the disease (Table I).

TABLE I.—LOCAL RECURRENCE AND REGIONAL METASTASES IN RELATION TO INITIAL TREATMENT

Initial treatment	*No. patients*	*No. patients with local recurrence*	*No. patients with regional metastases*
Local excision	8	7	4
Electrodesiccation	2	2	2
Local excision with single node excision	3	3	3
Excision and graft	3	1	1
En bloc	4	2	4
Totals	20	15	14



a b

FIG. 1. Histologic appearance of: a, the experimental Cloudman melanoma; b, a human melanoma.

Six of the 8 patients with disease still limited to the head and neck area presented primary lesions, 3 of which had obviously metastasized to regional lymph nodes. One patient had had previous adequate therapy of the primary lesion but was referred because of regional node metastases. Another had no evidence of disease since a melanoma of the cheek had been excised locally 2 weeks prior to admission, but he was admitted for a more adequate local excision in continuity with a prophylactic dissection of the neck. Operation in each case consisted of wide excision of the primary site in continuity with radical dissection of the regional lymph nodes.

Follow-up studies of this operable group disclosed that 4 patients were alive and without recurrence 16 to 28 months after treatment (Table II). The remaining 4 patients died 5 to 17 months after operation; and all had either regional node metastases or muscle invasion in the region of the primary site at time of treatment here. Radical surgery also failed to control the local disease in 2 patients who expired. It is significant that in all of the surviving patients the melanoma was confined to the primary site.

FIG. 2. Appearance of metastatic implants in mouse lungs produced by intravascular inoculation.

From the entire series, 17 autopsies were obtained and wide dissemination of melanoma was found in all cases. The lungs and liver were the most frequent sites of visceral metastases which in order of their frequency were: lungs in 17 cases, liver in 16, brain in 11, heart in 9, bowel in 9, kidney in 8, adrenal in 7, ovaries in 6, pancreas in 5, thyroid in 3, spleen in 3, and uterus in 2 instances.

For later comparisons, it is important to re-emphasize the findings of frequent recurrence of melanoma at the primary site, the high incidence of regional node metastases, and the widespread dissemination of disease found at death.

EXPERIMENTAL DATA

The experimental transplantable mouse melanoma, Cloudman S91, has been studied extensively. This tumor arose in the DBA mouse and has a characteristic histologic appearance similar to that seen in some human melanomas (Fig. 1). This tumor readily metastasizes to the lungs, but in our experience has never been seen to metastasize from a "primary" tumor to any other organ or to regional lymph nodes. It will, however, grow in skin, subcutaneous tissue, muscle, liver, spleen, and thoracic and abdominal cavities after direct inoculation. Pulmonary implants have also been seen after direct placement of inoculum into the trachea. Amputation of an extremity bearing a large tumor has led to local recurrence in less than 2 per cent of all animals. When placed subcutaneously, the developing tumor will not invade surrounding muscle. Local muscle invasion is seen upon transplanting the Cloudman melano-

ma intramuscularly, but this will confine itself to the muscle in which the inoculum was placed.

With the assumption that an increase in the number of circulating tumor cells would produce wide dissemination, the following experiments were undertaken. Tumor inoculum was prepared by cytosieving 1 gram of freshly excised tumor tissue into 10 cubic centimeters of heparinized physiologic saline and 0.05 cubic centimeter (200,000 to 400,000 cells) of a 1:10 dilution was used as an inoculum for DBA mice 2 to 3 months of age. Artificial intravascular transfer was accomplished in the tail artery and vein, the left ventricle, the portal vein, and the carotid artery. In introducing cells into the carotid artery, it was necessary to divide the dose between the right and left carotid to prevent a significant mortality rate with inoculation. At death or sacrifice a search for metastatic tumors was made in all animals in these experiments.

In no animal were artificial metastatic nodules found other than in the lungs (Fig. 2). Counting these lesions with a 3D magnifier, variation in the number was found depending upon the site injected (Table III). Injection into the tail vein yielded the greatest number of pulmonary implants, and a marked reduction in the number of implants was noted following injection into other blood vessels.

Attempts to increase further the intravascular inoculum in the DBA mouse failed because of immediate death of the animal. The inoculation dose could be increased to 0.1 cubic centimeter in the tail artery and vein, and the portal vein by using the hybrid, C × DBA/2F$_1$. The Cloudman melanoma grows well in this animal and demonstrates the same behavior characteristics seen in the DBA mouse. Hepatic nodules of melanoma tumor growth were seen in 5 of 10 animals 21 days after injection into the portal vein. The number of nodules seen ranged from 2 to 6, while in each animal the pulmonary growth was confluent and uncountable. After injection of this increased inoculum into the tail artery and vein, tumor implantation was again restricted to the lungs where the growth was confluent.

FIG. 3. Gross photograph of hindquarters of NIH white mouse 21 days after tail artery injection of S37 inoculum. Note growth of tumor in the musculature of back and thighs.

The persistent affinity of the Cloudman melanoma for pulmonary tissue raised important questions. When sarcoma 37 cells are injected forcibly into the tail artery, tumor grows in the musculature of the back and thighs (Fig. 3), but this did not occur with the Cloudman melanoma. Free grafts of pulmonary tissue from newborn DBA mice were placed into the thighs of 10 adult animals of the same strain. Ten days later, Cloudman melanoma was injected into the tail artery of each animal. The animals were

TABLE II.—EARLY RESULTS OF RADICAL SURGERY IN 8 MELANOMA PATIENTS IN RELATION TO STATUS OF DISEASE

Status of disease	*No. patients*	*Local recurrence*	*Living*	*Dead*
Primary only	3	0	3	0
Primary and regional nodes	3	1	0	3
Regional nodes only	1	1	0	1
No evidence of disease	1	0	1	0
Totals	8	2	4	4

TABLE III.—VARIATION IN PULMONARY COUNTS IN RELATION TO INTRAVASCULAR INOCULATION SITE

Site	*No. animals*	*Average no. lung implants*	*Range*
1. Tail vein	20	320	160–485
2. Tail artery	20	68	37–134
3. Left ventricle	30	32	18–108
4. Portal vein	10	82	42–180
5. Carotid artery	20	16	2–36

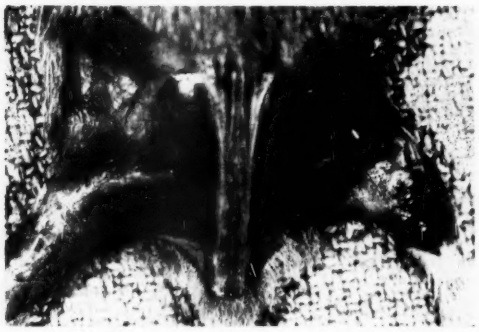


FIG. 4. Gross photograph of hindquarters of DBA mouse with melanoma implant growing in a graft of pulmonary tissue. Note absence of growth in other areas.

sacrificed 21 days after inoculation and the pulmonary graft contained melanomatous nodules (Fig. 4 and 5). The lungs again contained tumor implants, averaging 46 in number with a range from 20 to 83. Thus despite conversion of the lung into a nonfunctioning organ and placing it in a new anatomic position, thereby changing its vascular supply, lung tissue maintains its affinity for the Cloudman melanoma cells and supports growth of vascular implants.

DISCUSSION

The attempt to study the biologic behavior of human melanoma through the use of histologically similar mouse melanoma was met with failure. The restriction of metastases of the Cloudman melanoma is in direct contrast to the variation of metastases seen in 28 patients with malignant melanoma originating from a primary site in the head and neck. The Cloudman melanoma has limited invasive properties which may explain why lymphatic permeation is not seen. Further support of this argument is given in findings by Harris and Banfield in their work with a transplantable hamster melanoma. This experimental melanoma is more invasive than the Cloudman melanoma, and regional node metastases occurred frequently. Pulmonary metastases were also frequently observed, but hepatic and other visceral metastases were an exceptional finding.

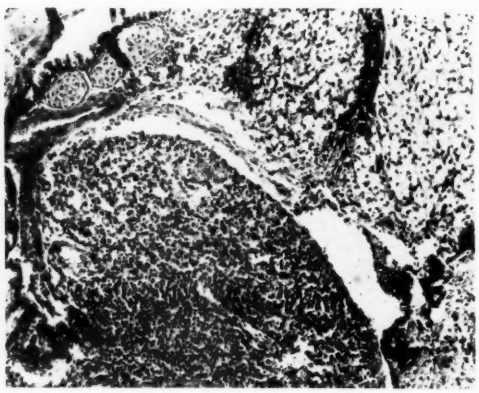


FIG. 5. Photomicrograph of pulmonary graft seen in Figure 4. Tumor infiltration lies adjacent to a bronchus and remnant of pulmonary tissue.

The reason for prolific development of metastatic implants of Cloudman melanoma solely in the lungs remains obscure. Even with a tremendous number of cells being introduced into the portal vein, hepatic implants were few in number, while confluent tumor growth was seen in the lungs of animals receiving portal vein inoculation of this magnitude. The variation in the number of pulmonary lesions counted at each site of intravascular transfer suggests trapping of cells by other organs with inability of these cells to implant and grow. The affinity of the Cloudman melanoma for pulmonary tissue is not dependent upon the anatomic location of the lung or its respiratory function, as shown by growth of tumor in pulmonary grafts placed in the thighs of animals later given a tumor inoculation via the tail artery. Bierman (1, 2) has shown that the lung has a prodigious capacity for both withdrawal and delivery of leucocytes from and into the blood. Perhaps this function of cellular filtration is responsible for the relative ease of the Cloudman melanoma to establish itself and grow in pulmonary tissue.

The contrasts in tumor behavior between the human and the experimental mouse melanoma illustrate the difficulties in making direct interrelationships of results in the laboratory animal to the clinical situation. The complexities found in the response of

the host to his tumor and the intrinsic properties of individual tumors add further skepticism to clinical conclusions based on laboratory animal studies. Laboratory animal findings serve best as a stimulus for parallel studies in the human being.

SUMMARY

A comparison has been made between the biologic behavior of human malignant melanoma and that of an experimental mouse melanoma. The differences found as to local invasiveness, regional node metastases, and pattern of dissemination illustrate the danger of interrelating directly results of animal cancer study to the clinical situation.

REFERENCES

1. BIERMAN, H. R., KELLY, K. H., PETRAKIS, N. L., CORDES, F., FOSTER, M., and LOSE, E. The effect of intravenous histamine administration on the level of the white blood count in the peripheral blood. Blood, N. Y., 1951, 6: 926–935.
2. BIERMAN, H. R., KELLY, K. H., KING, F. W., and PETRAKIS, N. L. The pulmonary circulation as a source of leukocytes and platelets in man. Science, 1951, 114: 276–277.
3. COTCHIN, E. Melanotic tumors of domestic mammals. In: Neoplasms of Domesticated Mammals. Chap. 1. London: Commonwealth Agricultural Bureaux, 1956.
4. HARRIS, ALVIN, and BANFIELD, WILLIAM. Personal communication. 1959.

A CLINICOPATHOLOGIC REVIEW OF 80 CASES OF STRUMA LYMPHOMATOSA

ARTHUR A. STEIN, M.D., Albany, New York

FOUR SIMILAR CASES of goiter believed to represent an unrecognized type of thyroiditis, distinct from the eisenharte variety previously described by Riedel, were reported by Hashimoto in 1912. In subsequent years, the elusive nature of Hashimoto's thyroiditis and its relation to Riedel's thyroiditis have been vigorously debated. Through the addition of "exact" gross, microscopic, and clinical characteristics an intangible entity, Hashimoto's disease, has arisen. More recently, Goldberg and Davson, Statland and associates, and Lindsey and associates, each reviewing an adequate number of cases, indicated that the characteristics of the disease are too confining.

However, there is universal agreement on the following features: The overwhelming majority of patients are women who seek medical advice because of a nontender goiter. Pressure symptoms usually are minimal but at times the major complaints are associated with obvious hypothyroidism. Clinical examination reveals a nontender, bilaterally enlarged, firm, nonadherent thyroid gland, and, on occasions, the signs of hypothyroidism. At surgical exploration, the gland is firm, bosselated, tan, and diffusely, although not necessarily symmetrically, enlarged. As Hashimoto stated, the goiter tends to hug and encircle the trachea. The capsule anteriorly and laterally is thin, but posteriorly some thickening and a few fibrous adhesions to the trachea may be seen. Diffuse dense adhesions to surrounding structures, as described in Riedel's cases, never are present. On cut section the thyroid parenchyma presents a smooth, tan, firm, lobulated surface. The lobules vary from 0.3 to 1.0 centimeter in diameter and are separated by fibrous bands of varying thickness. There are no zones of hemorrhage, cystic degeneration, or adenomatous nodule formation.

The microscopic criteria of the disease are not nearly as exact. The presence of lymphoid follicles, lymphocytic infiltration, fibrosis, epithelial cell alterations, and giant cells serves to establish a diagnosis of thyroiditis. But, differences in proportion of these features as well as variations in the underlying acinar pattern are used to separate lymphoid thyrotoxicosis, diffuse lymphadenoid goiter, chronic nonspecific thyroiditis, Hashimoto's disease, and Riedel's struma. Actually, most authorities frankly admit that, on microscopic examination alone, they are unable to distinguish this disease entity because identical histologic features may be seen in selected sections from many types of goiter.

A review of 143 cases of diffuse chronic thyroiditis in which operation was performed at Albany Hospital since 1937 yielded a series of 80 cases, in each of which were present clinically and grossly these generally acceptable features of Hashimoto's disease.

Parmley and Hellwig, with similar material, by measurement of lymphoid and epithelial tissues in paraffin sections, determined that only one-third of the glandular enlargement was due to lymphoid proliferation, while two-thirds of the gland was composed of epithelial structures. Statland and associates roughly estimated the comparative microscopic volume of parenchymal and lymphoid elements in struma lymphomatosa and found slightly more than half of the goiter was composed of

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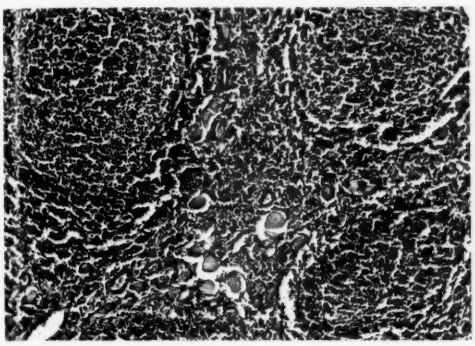

FIG. 1. The microfollicular parenchyma is virtually obscured by large lymphoid follicles with active germinal centers. Hematoxylin and eosin, × 52.

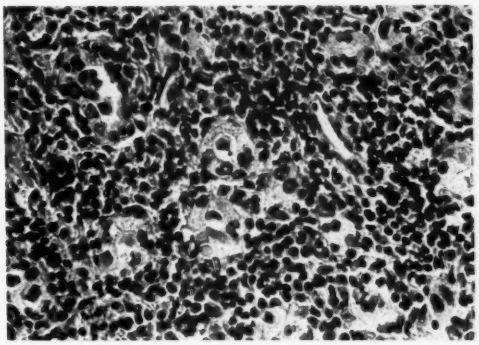

FIG. 2. The microfollicles are separated by an infiltrate of lymphocytes, plasma cells and macrophages. Hematoxylin and eosin, × 283.

acini. Such measurements of epithelial content, in conjunction with gross glandular enlargement, indicated by size and weight as above normal, reveal a common basic underlying state of epithelial hyperplasia.

Since there is great disagreement concerning the microscopic characteristics of the disease, each gland was re-evaluated histologically.

Although in each gland microfollicles and macrofollicles, two distinct histologic types of acinar structure, were found, the overwhelming preponderance of the microfollicular variant was readily apparent. Careful study indicated these two types of follicles presented different, although characteristic, patterns of hyperplasia and involution (14). In contrast to the macrofollicular morphologic alterations which are related to iodine metabolism, there is no known chemical associate with the microfollicular variations. However, each of our cases of diffuse microfollicular hyperplasia showed zones of macrofollicular hyperplasia to a greater or lesser extent. Although microfollicular hyperplasia, by budding or hollowing out of solid epithelial nests, can be well appreciated in adolescent goiter or so-called fetal adenoma, the process of involution is worthy of careful description.

With microacinar hyperplasia, there was progressive thickening of the interlobular septa. The major arteries showed no characteristic alterations. With the initiation of spontaneous involution the lymphoid follicles began to appear immediately beneath the capsule or beneath thickened trabeculae which subdivided the gland into lobules. As the lymphoid follicles grew, they developed active germinal centers (Fig. 1). The adjacent acinar parenchyma virtually melted in the advancing margin of these expanding follicles without creating any visible mesenchymal reaction. The acinar epithelial cell did, or did not, show focal or diffuse Hürthle-like alteration. The cytoplasm of these altered cells was deeply eosinophilic and increased in amount. The nuclei remained regular, oval, or rounded and basal. The cause of this Hürthle-like change remains unsolved, but it probably represents a reversible metaplastic phenomenon.

Up to this stage, the progress of spontaneous involution to a large extent may be reversible. This capability would account for Hashimoto's original and other occasional reports of spontaneous regression or of regression following partial resection of known goiter without subsequent permanent hypothyroidism.

The irreversible steps in the development of spontaneous involution were initiated by stromal infiltration by lymphocytes and few plasma cells (Fig. 2). As this cellular infiltrate became more dense, the endothelial cells of the stromal capillaries and small

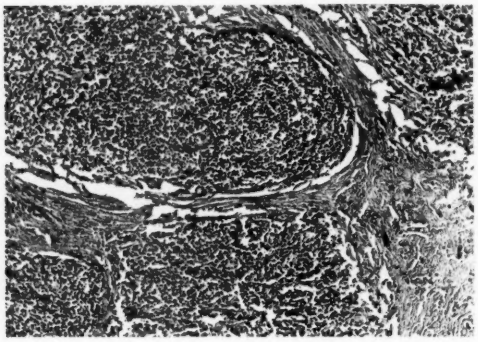

FIG. 3. Note the perilobular fibrosis. Hematoxylin and eosin, × 52.

arterioles show marked swelling and hyperplasia with reduction in the caliber of the lumens. Degenerative changes in the acinar cells were indicated by cytoplasmic swelling, pallor, and accumulation of multiple basal vacuoles. The nuclei tended to migrate to the midzone or apex of the cell and were large, pleomorphic, hyperchromatic, and lost normal polarity. As the acinar cells separated inferiorly and laterally, lymphocytes and plasma cells slipped between them into the colloid. Associated with these vascular and epithelial changes there appeared intralobular fibrosis (Fig. 3), which first was manifested by hyaline thickening of the stromal reticular fibers, and capillary walls. Later the strangulated acini disappeared.

In some situations there resulted diffuse scarring of the gland, and in other places there was progressive reduction in the size of the functional lobules, with apparent increase in the thickness of the interlobular septa. In conjunction, the amount of lymphoid nodule formation and lymphocytic infiltration receded.

SUMMARY OF CLINICAL REVIEW

Although there was a wide variation in the age of these patients, from 10 to 70 years, the average age for the group was 53.5 years. It is significant to note that the average age of the patients with diffuse hyperplastic microfollicular goiter with late morphologic changes of involution was about 10 years more than the average age of the group with the earliest changes of spontaneous involution. This 10 year difference indicates that spontaneous involution of microfollicular hyperplasia is a prolonged process which may take many years. The opportunity of examining residual or recurrent thyroid tissue in a patient who, on initial surgery, proved to have Hashimoto's disease has occurred on rare occasion. In these instances the morphology is said to be unchanged even though in 1 case 9 years had elapsed since the original surgery.

Ninety-three per cent of the patients were women and 7 per cent men. The primary complaint of more than half (58 per cent) of the patients was the presence of goiter. Thirteen per cent noted toxic features in addition to glandular enlargement. Thirteen per cent complained only of toxicity; in addition to the presence of goiter, 5 per cent noted hypothyroid phenomena; 2 per cent were seen with signs and symptoms of myxedema; and 10 per cent of the patients suffered pressure effects, such as fullness or tightness in the neck, choking sensation, or dysphagia. Clinically, 40 per cent of this group had some suggestive toxic features; 31 per cent were euthyroid; and 14 per cent were myxedematous. A curious mixture of toxic and myxedematous features were present in 14.5 per cent. Exophthalmos was noted in 8.5 per cent of these patients. From the few recorded, it appears that increased basal metabolic rates may be present but rarely are markedly elevated. Decreased metabolic rates tend to be more frequent and severe as the progress of involution proceeds. In general, clinical features of myxedema become progressively more prominent in the late stage of involution.

Some investigators vigorously deny and others faithfully record the preoperative presence of clinical hyperthyroidism. It would seem the difference in clinical history is a reflection of the variation in proportion of hyperplastic microfollicular and macrofollicular elements. Curious admixtures of

clinical hypothyroid and hyperthyroid activity also appeared. The atypical thyrotoxicosis that Hertzler described and the placid hyperthyroid patients that Crotti recorded are clinical images of a particular balance between hyperplastic microfollicular and macrofollicular elements. It is also necessary to emphasize that the clinical status of these patients, because of therapeutic or spontaneous glandular involution, will alter with time. In the end stage all glands will be hypoactive.

Many patients were aware of the presence of goiter for variable periods, in several instances as long as 30 years. Forty-three per cent had had recognized glandular enlargement for 5 years or more. New complaints, either onset of toxicity, glandular enlargement, pressure effects, or hypothyroid features noted in the preceding few weeks or months precipitated medical aid in 41 per cent of this series.

On palpation, 90 per cent of the glands were considered to be nodular. At exploration, the surgeon noted in 9 per cent the association of enlarged lymph nodes which on section showed marked hyperplasia with active germinal centers. Nine and one-half per cent of the glands had few adhesions to the surrounding structures which necessitated sharp dissection. In no case were these adhesions diffuse and densely binding. The average weight of the subtotally resected glands was 32 grams.

It appeared that, with the onset of spontaneous involution, initially the gland increased in size and weight but in the late stage it became small and sclerosed.

As a group there was no apparent tendency to obesity, sterility, or menstrual disorders. The proportion of Jewish patients in this group was smaller than expected.

Almost every patient after subtotal resection had signs and symptoms of myxedema within a few weeks. These patients needed and received comparatively large doses, 1 to 3 grains, of desiccated thyroid daily and showed no sensitivity to thyroid on initiation of therapy. In our group, follow-up examination indicated the need for continuous medication. Except for the relief of pressure symptoms, subtotal resection of these glands, even if the diagnosis is delayed until surgical exploration, seems unnecessary. At the time of surgical exploration, the awakened surgeon can usually make the correct gross diagnosis. Any surgical procedure only hastens the inevitable hypothyroidism.

DISCUSSION

The known presence of goiter in about half of these patients for at least 5 years, and in many instances recalled since childhood or adolescence, would indicate that a diffuse nontender symptomless goiter usually preceded the onset of spontaneous involution. What is the nature of this precursor? The logical antecedent struma supported by study of the basic acinar pattern is diffuse, predominantly microfollicular goiter (parenchymatous or adolescent goiter).

What is the etiology of microfollicular goiter? What precipitates microfollicular hyperplasia? What facilitates or initiates the onset of spontaneous involution? None of these questions can be answered satisfactorily. Microfollicular goiter has a definite geographic distribution. This type of struma occurs most frequently in high altitude endemic goiter areas. In the United States, microfollicular type of goiter is infrequent as compared to the macrofollicular variety. At Wichita, Kansas, Hellwig reported a 13.9 per cent incidence of microfollicular goiters in surgical material. An 8.3 per cent incidence in Wisconsin and 6.8 per cent incidence in Ann Arbor were recorded by Coller. It may well be that a relative or absolute lack of a specific element as yet unrecognized will prove responsible for the development of microfollicular goiter. McCarrison was able to produce lymphadenoid goiters in rats by a deficient diet. Marine's classical experiments demonstrated the relation of iodine deficiency to macrofollicular goiter, but there has been an inadequate experimental attack on the problem of microfollicular goiter.

Reinhoff believed the hyperplastic microfollicular foci seen in diffuse toxic goiter represented zones of hypoinvolution with temporarily decreased blood supply. Goldberg and Davson concurred with this interpretation and enlarged it to include similar foci of microfollicular hyperplasia seen in adenomatous goiters. Parmley and Hellwig believed that the microacini were the product of overstimulation by thyrotropic hormone with resultant inability to store colloid. McClintock and Wright insisted that microacini of Hashimoto's disease were atrophic structures even though the lining acinar cells repeatedly were described as large. In truth, the factors precipitating hyperplasia are not clear. We do know the hyperplastic microacini do not respond to iodine administration. Judging by the inadequate quantity and quality of colloid within these follicles, there is also either a basic defect in its biosynthesis or storage.

The factors that initiate the spontaneous involution of hyperplastic microfollicles also are unknown. It appears that before the advent of acinar cell degeneration spontaneous reversal of this process may occur. The course of involution may take years, and the gland terminally will be small and diffusely fibrosed. Clinical progressive hypofunction of the thyroid will be noted and associated changes in pituitary and adrenal glands can be expected.

SUMMARY

Between the years 1937 and 1953, at Albany Hospital 143 patients were operated upon for goiter which had been diagnosed as struma lymphomatosa (Hashimoto). On review, the generally acceptable features of Hashimoto's disease were present in 80 of these cases. The available clinical records and the pathologic material regarding these cases were carefully studied. Morphologically, the thyroid gland was composed of a balance of two types of epithelial structures, microfollicles and macrofollicles. Each follicular variant had distinct patterns of hyperplasia and involution. The variation in number and functional activity of these two epithelial structures created graded differences in morphologic pattern. The variations in clinical features merely reflected the proportion and activity of these two structural units.

REFERENCES

1. Coller, F. A. The morbidity of endemic goiter. J. Am. M. Ass., 1924, 82: 1745–1748.
2. Crotti, A. Diseases of the Thyroid, Parathyroids, and Thymus. 3rd ed. Philadelphia: Lea & Febiger, 1938.
3. Goldberg, J. M., and Davson, J. Lymphadenoid goiter. Brit. J. Surg., 1948, 36: 41–48.
4. Hashimoto, H. Zur Kenntnis der Lymphomatosen veranderungen der Schilddruese (struma lymphomatosa). Arch. klin. Chir., 1912, 97: 219–248.
5. Hellwig, C. A. Geographic pathology of goiter. Surg. Gyn. Obst., 1932, 55: 35–44.
6. Hertzler, A. E. Diseases of the Thyroid Gland. 1st ed. New York: Paul B. Hoeber, Inc., 1941.
7. Lindsey, S., Dailey, M. E., Freedlander, J., Yee, G., and Soley, M. H. Chronic thyroiditis; a clinical and pathological study of 354 patients. J. Clin. Endocr., 1952, 12: 1578–1600.
8. McCarrison, R. Note on the experimental production of lymphadenoid goiters in rats. Brit. M. J., 1929, 1: 5–6.
9. McClintock, J. C., and Wright, A. W. Riedel's struma and struma lymphomatosa (Hashimoto). Ann. Surg., 1937, 106: 11–32.
10. Parmley, C. C., and Hellwig, C. A. Lymphadenoid goiter; its differentiation from chronic thyroiditis. Arch. Surg., 1946, 53: 190–198.
11. Riedel, B. M. C. L. Die chronische Bildung eisenharter Tumoren fuehrende Entzuendung der Schilddruese. Ver. Deut. Ges. Chir., 1896, 25: 101.
12. Rienhoff, W. F., Jr. Involutional or regressive changes in the thyroid gland in cases of exophthalmic goiter. Arch. Surg., 1926, 13: 391–425.
13. Statland, H., Wasserman, M. M., and Vickery, A. L. Struma lymphomatosa (Hashimoto struma). Arch. Int. M., Chic., 1951, 88: 659–678.
14. Stein, A. A. The role of the microfollicle in non-neoplastic non-infectious goiter. Arch. Path., Chic., 1959, 67: 168–174.

THE EMERGENCY PORTACAVAL SHUNT

GEORGE E. WANTZ, M.D., F.A.C.S., and MARY ANN PAYNE, M.D., New York, New York

WHENEVER POSSIBLE, we have treated bleeding esophagogastric varices by decompressing the portal bed with an end-to-side portacaval shunt as soon as the hemorrhage has been controlled by esophageal tamponade, and the patient's vital signs have been stabilized. Not only does this method of management control the immediate emergency; it also prevents its recurrence.

This policy was adopted to obviate the failures associated with alternative procedures. For instance, although pneumatic tamponade has proved an effective method of dealing with most actively bleeding esophageal varices, it does not control all of them, nor does it assure that hemorrhage will not recur upon deflation of the balloon. Too frequently, the bleeding recurs immediately, or before the patient can be adequately prepared for elective portal decompression. Moreover, it commonly leads to hazardous complications. Among these are: pressure necrosis of the nose, pharynx, esophagus, and stomach; perforation of the esophagus and stomach; and aspiration pneumonia. These disadvantages of esophageal tamponade have led others to perform operations designed to control the bleeding varix directly at its source until definitive portal decompression could be performed. Although their advocates contend that such operations are of less magnitude than portacaval shunts, they have carried a significantly high mortality. Furthermore, these procedures also have the disadvantages that they neither insure the cessation of hemorrhage nor prevent its recurrence.

In this report is presented an analysis of our experiences with emergency end-to-side portacaval shunt at The New York Hospital-Cornell Medical Center since 1950.

From the Departments of Surgery and Medicine, The New York Hospital-Cornell Medical Center, New York.

MATERIALS

There were 24 patients who fell into three categories: (1) those in whom all nonoperative measures failed to control the hemorrhage; (2) those in whom bleeding was controlled, but repeatedly recurred immediately or within 1 to 3 days after deflation of the esophageal balloon; and (3) those in whom effective esophageal tamponade was established but operation, nevertheless, was performed promptly without attempting to deflate the balloon. Hemorrhage was immediately and permanently controlled in all the patients in whom a successful shunt was performed. Eleven of the 24 patients died—an operative mortality rate of 41.7 per cent.

The series was comprised of 7 women and 17 men. Their ages ranged from 16 to 70 years and averaged 47.7 years. The average age of those who died was 47.9 years.

Fifteen patients had alcoholic cirrhosis, and 1 of these had a hepatoma. Four patients had postnecrotic cirrhosis, and 1 of these also had hepatic endophlebitis. Four patients had primary biliary cirrhosis, and in 1 of these it was associated with hepatoma. Finally, there was 1 patient with a proliferative endophlebitis of the hepatic veins. Both instances of hepatic endophlebitis and both instances of hepatoma went unrecognized until post-mortem examination. Two patients were also known to have a chronic duodenal ulcer and another a marginal ulcer. That all 3 patients with ulcers were bleeding from esophageal varices was indicated by the fact that pneumatic tamponade immediately controlled the hemorrhages.

The patients received an average of 5,500 cubic centimeters of blood preoperatively to replace blood loss and combat shock. However, those who were operated upon without deflation of the esophageal balloon received

TABLE I.—MORTALITY IN ELECTIVE END-TO-SIDE PORTACAVAL SHUNT

Degree of hepatic disease	*No. of patients*	*Postoperative deaths*	*Mortality, per cent*
A. Mild	33	1	2.9
B. Moderate	31	5	16.1
C. Advanced	11	5	45.5
Total	75	11	14.7
A and B (good risk patients)	64	6	9.4

TABLE II.—MORTALITY IN EMERGENCY END-TO-SIDE PORTACAVAL SHUNT

Degree of hepatic disease	*No. of patients*	*Postoperative deaths*
A. Mild	3	0
B. Moderate	4	0
C. Advanced	17	11
Total	24	11

an average of only 2,250 cubic centimeters, whereas the remaining received an average of 7,500 cubic centimeters. None of the patients were in hepatic coma at the time of operation. All operations were performed under normothermic conditions.

Portal pressure averaged 49.4 centimeters of saline, whereas the median portal pressure was 43 centimeters. These pressures are significantly higher than the average as well as the median portal pressure of 38 centimeters encountered in our patients with cirrhosis who have undergone an elective portacaval shunt. This observation supports the concept that portal pressure and not peptic esophageal erosion is the chief precipitating cause of bleeding esophagogastric varices.

All but 1 patient was operated upon with pneumatic tamponade in place. With 1 exception this was continued, but at reduced luminal tension, for 12 to 24 hours postoperatively, providing it had been effective in controlling hemorrhage preoperatively. Overcautiousness led us to maintain esophageal tamponade for 48 hours in our first patient. Another, the patient with proliferative endophlebitis of the hepatic veins, bled to death despite continued esophageal tamponade, but thrombosis of the portacaval anastomosis was found at autopsy. Although ascites curiously had never been present preoperatively in this patient, it is doubtful that he would have survived this incorrectly chosen shunt, even if the thrombosis had not occurred. Partially controlled ascites existed in the other patient in whom there was hepatic endophlebitis as well as postnecrotic cirrhosis. While hemorrhage ceased following end-to-side portacaval shunt, the ascites became extremely severe, and death quickly followed owing to uncontrollable ascitic fluid loss when the abdominal incision sprung a leak 4 weeks postoperatively.

Not all of the patients had the same degree of hepatic disease. In some patients it was obviously mild, while in others it was moderate or advanced. Because a comparison of operative mortality among patients with mild and advanced cirrhosis is misleading, they have been classified into 3 groups according to hepatic damage. These may be easily and quickly delineated without extensive clinical and laboratory evaluation and have proved useful in predicting operative risk.

Group A. Patients are considered to have mild hepatic disease if they have a bilirubin of less than 2.0 milligrams per cent and an albumin greater than 3.5 grams per cent, have never been in a coma, and do not exhibit ascites or muscle wasting. Such individuals participate in normal activities.

Group B. Patients are considered to have moderate hepatic damage when icterus is recognizable but the bilirubin is less than 3.0 milligrams per cent. Never more than moderate muscle wasting is present, and the serum albumin usually is 3.0 to 3.5 grams per cent. These patients have never been in a coma, and if ascites is present it is at most transient and easily controlled.

Group C. Patients with advanced hepatic disease are easily recognized. Jaundice is normally present and the serum albumin is usually below 3.0 grams per cent. These patients exhibit frank muscle wasting and frequently have been in a coma. Ascites is generally present and difficult to manage.

That this classification is useful in evaluating candidates and predicting operative risk under stable conditions is clearly evi-

dent in our elective portacaval shunt series (Table I). The mortality rate among the good risk patients was 9.4 per cent. Among the 11 patients with advanced cirrhosis, however, the postoperative mortality rate was 45.5 per cent. This classification also holds for evaluation of candidates for the emergency portacaval shunts (Table II). None of the 7 good risk patients died. On the other hand, 11, or 64.7 per cent, of the 17 patients with little hepatic reserve died.

Review of the cases, however, revealed additional information important in predicting operative risk (Table III). The over-all condition of the patient, as judged by muscle wasting, as well as pre-existing coma and jaundice, constituted the significant prognostic features since 6 of 8 patients with marked atrophy of the muscles died and 5 of the 8 patients who had been in a coma before the operation also died. That the serum bilirubin level is singularly significant is evidenced by the fact that the only 3 survivors of 9 patients with a serum bilirubin exceeding 4 milligrams per cent had biliary cirrhosis which is characterized by chronic jaundice. This fact suggests that this level of icterus may be a definite contraindication to emergency operations in patients with portal cirrhosis. Sometimes jaundice may precede all other clinical evidence of approaching hepatic collapse.

By themselves, refractory ascites and low serum albumin were of less prognostic importance. For instance, although mortality was less if the serum albumin was greater than 3.5 grams per cent, diminishing quantities were not associated with a greater mortality. Similarly, patients with refractory ascites fared as well as those without it.

One may legitimately ask why these poor risk patients who were bleeding were submitted to an operation of the magnitude of portacaval shunt. Certainly any one, or all, of the patients with advanced hepatic disease, as appraised by the criteria given, could have been denied operation. Furthermore, in many, hepatic reserve and consequently operative risk might have improved

TABLE III.—CORRELATION OF INDIVIDUAL FEATURES OF HEPATIC DISEASE WITH POSTOPERATIVE DEATHS IN 24 PATIENTS WHO UNDERWENT AN EMERGENCY END-TO-SIDE PORTACAVAL SHUNT

	No. of patients	*No. of deaths*
Serum bilirubin, mgm. per cent		
1.9 or less	6	2
2.0–2.9	4	1
3.0–3.9	5	2
4.0 or more	9*	6
Coma		
Never	12	4
Precoma	4	2
Coma	8	5
Muscle wasting		
None	6	2
Moderate	10	3
Marked	8	6
Serum albumin, gm. per cent		
3.5 or more	8	3
3.4–3.0	12	6
2.9–2.5	2	1
2.4 or less	2	1
Ascites		
None or transient	12	5
Refractory	12	6

*The 3 survivors had biliary cirrhosis.

with salt restriction and with a nutritious, alcohol-free diet while, in some, hemorrhage might precipitate the terminal phase of the disease.

The answers to these questions will become apparent when the characteristics of the hemorrhage and the indication for operation in these patients are considered.

In 11 patients shunts were used because bleeding recurred immediately or within 1 to 3 days upon deflation of the esophageal balloon (Table IV). Among these, bleeding had recurred once in 3, twice in 3, and 3 times in 5. The 4 deaths, all of patients who had advanced hepatic disease, occurred among the latter groups. Two of the deaths resulted from liver failure, but in 1 of these a hepatoma was also present. The other 2 were the patients with hepatic endophlebitis mentioned earlier. That 9 patients of this group had almost frank hepatic decompensation clearly demonstrates the propensity of such patients to have early recurrent hemorrhage.

The fact that patients with cirrhosis deteriorate with recurrent bleeding led us to

TABLE IV.—RESULTS OF EMERGENCY PORTACAVAL SHUNT CORRELATED WITH THE DEGREE OF HEPATIC DISEASE AND THE CHARACTERISTICS OF THE HEMORRHAGE

Characteristics of hemorrhage	*Degree of hepatic disease*	*No. of patients*	*Postoperative deaths*
Immediate or very early recurrent hemorrhage after esophageal tamponade	A. Mild	1	0
	B. Moderate	1	0
	C. Marked	9	4
	Total	11	4
Hemorrhage controlled by esophageal balloon and operation performed promptly	A. Mild	2	0
	B. Moderate	3	0
	C. Marked	2	2
	Total	7	2
Uncontrollable hemorrhage from esophagogastric varices	A. Mild	—	—
	B. Moderate	—	—
	C. Marked	6	5
	Total	6	5

attempt early portal decompression in an effort to salvage more of them. We were encouraged by the fact that patients with advanced cirrhosis and hepatic decompensation survived. Thus far, we have performed an end-to-side portacaval shunt in 7 patients without waiting to see if bleeding would recur upon discontinuing pneumatic tamponade (Table IV). But, whereas the 5 patients with mild or moderate cirrhosis recovered uneventfully, the 2 with advanced cirrhosis died.

Although this group is small, it does suggest that nothing is gained by performing an even earlier shunt in patients with advanced cirrhosis. However, since transfusion hepatitis and staphylococcal septicemia were the causes of death in these patients, grounds for this conclusion lose validity. Deaths in these 2 patients can hardly be blamed on the timing of the operation or the degree of hepatic disease.

The most difficult group of patients to manage are those who are bleeding massively from esophagogastric varices, despite correct nonoperative therapy. Providing they are not preterminal, operative intervention seems justifiable, since it offers these patients their only chance to survive. Care of these patients is at best complicated and taxing, and coma is a likely possibility since huge quantities of blood lie stagnant and septic in the postoperatively paralyzed bowel. Fortunately, uncontrollable hemorrhage from esophagogastric varices in other than terminal patients has been an uncommon event, occurring in less than 3 per cent of our total experience with this problem. It is even rarer when consideration is given to the fact that in half of these patients hemorrhage became uncontrollable after prolonged use of the esophageal balloon.

Results in this group were discouraging since only 1 of 6 such patients survived (Table IV). There was little consolation in the fact that all were patients with advanced liver disease, and that in all bleeding stopped almost immediately after creation of the shunt. Death in 1 patient resulted from aspiration pneumonia sustained preoperatively. Two died from liver failure, but again one of these patients had a hepatoma while another died 28 days postoperatively from chronic pyelonephritis and septicemia due to Pseudomonas pyocyaneus. The cause of death in the remaining patient is not entirely clear. He had drifted slowly into precoma, and on the third postoperative day, he suddenly stopped breathing after the injection of neomycin into the stomach via a Levin tube. The possibility that neomycin had entered the blood stream through gastric varices was tardily considered, but death ensued from encephalomalacia 2 days later.

Follow-up shows that 5 of the 13 patients who survived operation have died, and 1 was lost to follow-up after 2 years (Fig. 1). Four late deaths from liver failure occurred, 1 at 6 months, 2 at 16 and 27 months respectively, and 1 at 41 months after surgery. The remaining patient died of a bleeding marginal ulcer 18 months after operation. However, 7 patients are alive and well, 2 indeed at 6 and 7 years respectively after portacaval shunt.

DISCUSSION

It is not within the scope of this report to discuss the general management and diagnosis of patients bleeding from esophagogastric varices. Suffice it to say that unless bleeding is most minimal, hemorrhage

should be checked by prompt pneumatic tamponade, blood loss and shock corrected by transfusions, and the gut should be evacuated and sterilized. It is the management of these patients from this point on that has concerned us most. To begin with, however, we should like to re-emphasize that we have never advocated early operations of any magnitude in such patients when they are in shock or coma, or if, when first seen, they exhibit the stigmas of advanced cirrhosis or evidences of frank hepatic failure. Such patients must be treated expectantly. At this point, perhaps it should be explained that the 2 patients with advanced hepatic disease who were subjected to early portacaval shunt had been in the hospital for several weeks prior to the hemorrhage. Their conditions were stable, and further improvement of hepatic reserves was not expected. Hemorrhage in each one was checked extremely early after its onset, but operation was carried out despite the risk, because we realized that little, if any, improvement was likely from continued conservative treatment.

What has been said is that little is gained by expectant treatment of good risk patients with bleeding varices. That the 7 good risk patients in this series survived lends further support to this contention. While prolonged dietotherapy is admittedly effective in improving the general outlook of patients with cirrhosis, it is not essential in the immediate preoperative management of the good risk patient. To purchase the time necessary for prolonged dietotherapy by repeated pneumatic tamponade or by performing such unreliable stopgap expedients as ligation of the varices is to delay the ultimate solution of the problem and to subject the patient to the possible risk of being forced to undergo 2 major operations rather than 1 definitive procedure.

Unfortunately, the majority of patients who bleed from esophagogastric varices do so at times of impending hepatic failure, and often after bouts of extraheavy drinking. Although in these patients bleeding is

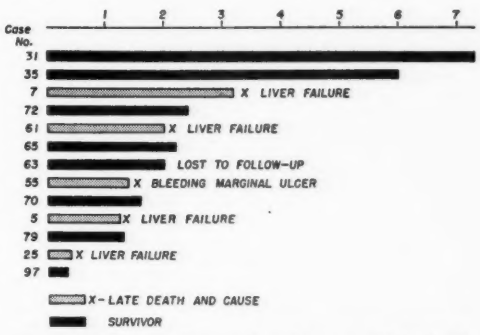

FIG. 1. Follow-up (in years) and causes of late deaths in the patients surviving emergency end-to-side portacaval shunt for esophagogastric hemorrhage.

most likely to recur after pneumatic tamponade, and although they tolerate hemorrhage most poorly, the immediate performance of any operation intended to stop hemorrhage is certainly unjustified. Even under stable conditions, operation on patients with advanced cirrhosis, who are comparable, has a mortality of about 40 to 50 per cent. It is in this group of patients that prolonged dietotherapy and salt and alcohol restriction are truly useful. By such therapy hepatic reserve may improve to the extent that portal decompression may be undertaken with negligible risks. The two possible exceptions to this rule are: (1) hemorrhage that cannot be even temporarily stopped by esophageal tamponade, and (2) hemorrhage occurring in the patient with advanced cirrhosis like the 2 in our series who had achieved a steady state while in the hospital.

Should bleeding recur upon deflation of the esophageal balloon, then one might finally resort to surgical intervention. Our experience indicates that patients with advanced hepatic disease, who are also bleeding, may successfully undergo an emergency portacaval shunt, and that hemorrhage will cease.

Of 15 poor risk patients with demonstrably unrelenting hemorrhage, 6 survived to lead normal lives. Although the operative mortality is bound to be high in these patients, without surgical intervention death seems inevitable. There is no evidence to

show that better results have been achieved by any other procedure.

Our experience further indicates that operation may be contraindicated in patients with alcoholic and postnecrotic cirrhosis, if the serum bilirubin exceeds 4 milligrams per cent. Of course, operation is useless in those who are obviously preterminal.

SUMMARY

Portacaval shunt need not be delayed in patients who have been in a steady state of comparatively good health prior to bleeding from esophagogastric varices. However, those patients whose health has progressively deteriorated before hemorrhage and in whom the bleeding represents additional evidence of hepatic decompensation should be given a trial of balloon tamponade. Providing the patient is not moribund or preterminal, portacaval shunt offers the only certain method of controlling massive hemorrhage which continues or recurs despite correct nonoperative treatment. However, operation is probably contraindicated in those patients with marked jaundice or with a serum bilirubin exceeding 4 milligrams per cent associated with portal cirrhosis.

THE THERAPY OF ACUTE SMALL BOWEL OBSTRUCTION

ANDREAS J. HØYER, M.D., and KAARE SOLHEIM, M.D., Oslo, Norway

THE PATIENTS in this series were treated at Ullevål Hospital, Surgical Department III, Oslo, from 1935 to 1957 inclusive. During this period of 23 years, the patients have been treated according to the principles advocated by the head of the department, Professor Carl Semb.

The directions given for the treatment of acute mechanical small bowel obstruction were:

1. No time should be lost in the establishment of the diagnosis in all patients suspected of having intestinal obstruction. Roentgenologic examination should be performed as quickly as possible.

2. The patient should not be operated on until preoperative treatment has produced a satisfactory condition. The main purpose of this treatment is to replace the loss of fluids and electrolytes. The stomach should be carefully aspirated by means of a duodenal tube inserted through the nose. The tube should remain *in situ* during the operation, draining the stomach, partly by syphonic effect and partly by the use of aspiration.

3. Once the patient has achieved a satisfactory preoperative condition, operation should be performed without delay.

4. The operative procedure should be as simple as possible to relieve the obstruction. Re-establishment of the normal intestinal passage is considered of secondary importance at this stage.

5. Control of the fluid and electrolyte balance is maintained during the postoperative course.

6. Since 1943 regular injections of prostigmine during the first few postoperative days have been given to secure early peristaltic movements.

From Ullevål Hospital, Surgical Department III, Oslo, Norway.

7. Penicillin has been used since 1946, and in combination with streptomycin since 1949. Later newer antibiotics have also been used.

From January 1, 1935 to December 31, 1957, 493 cases of small bowel obstruction have been treated (Table I). Intestinal obstructions due to external incarcerated hernias or malignant tumors are not included. The over-all mortality rate was 11.5 per cent. For the patients operated upon the mortality rate was 10.3 per cent. Strangulation occurred in 22.3 per cent.

Table II shows the mortality in the different age groups. The relatively high mortality in the first decade is due to the fact that this group has mainly consisted of newborn babies. The mortality rate increases with increasing age, a fact well known from other series. One of the causes of the high mortality rate in the aged patients is that far too often they are admitted too late, in a state too poor to tolerate operation.

NONSURGICAL PATIENTS

Thirty-eight of the patients were not operated on (Table III). In 16 cases, the obstruction gave way spontaneously during the preoperative treatment. All were typical cases of small bowel obstruction, clinically as well as roentgenologically.

TABLE I.—493 PATIENTS WITH MECHANICAL SMALL BOWEL OBSTRUCTION, 1935–1957

	No.	*Per cent*
Total number of patients	493	
Females	265	
Males	228	
Patients with strangulation	110	22.3
Operated upon	455	
Not operated upon	38	
Deaths	57	11.5
Of patients operated upon	47	10.3
Of patients not operated upon	10	26.3

TABLE II.—MORTALITY AND AGE IN 493 PATIENTS WITH SMALL BOWEL OBSTRUCTION

Age, years	*Operated upon*		*Not operated upon*		*Total*		*Mortality, per cent*
	No.	*Deaths*	*No.*	*Deaths*	*No.*	*Deaths*	
0– 10	32	5	13	0	45	5	11.1
11– 20	23	1	0	0	23	1	4.3
21– 30	54	1	0	0	54	1	1.8
31– 40	67	3	3	0	70	3	4.3
41– 50	80	4	8	1	88	5	5.7
51– 60	77	10	3	0	80	10	12.5
61– 70	59	9	2	0	61	9	14.7
71– 80	50	13	5	5	55	18	32.8
81–100	13	1	4	4	17	5	29.4
Total	455	47	38	10	493	57	
Mortality, per cent		10.3		26.3		11.5	

PREOPERATIVE TREATMENT

Preoperative correction of the loss of fluids and electrolytes has been routine throughout the whole period. Of the 455 patients operated upon, detailed information has been available in 363 (Table IV).

On the average, each patient has received 2,330 cubic centimeters of fluids. The greatest amount given to 1 single patient was 9,000 cubic centimeters. Patients with a short history usually require preoperative treatment of short duration which can take place simultaneously with the other preoperative preparations, thus preventing unnecessary loss of time. In patients with a long history, a longer and more thorough preoperative treatment is required. In these cases, the time factor is not so imperative as in the early cases because possible injury to the intestine already is established.

ANESTHESIA

The type of anesthesia used in this series is seen from Table V. In the first 17 years of the material, the typical anesthesia was spinal (221 of 300 cases). In the last 6 years, it has been general (148 of 155 cases).

OPERATIONS

The operations classed according to duration of symptoms at the time of operation are summarized in Table VI. The simplest operation claimed the lowest mortality. Furthermore, the table shows the great importance of the time factor. Independent of the age of the patient and the nature of the operation, none of the 60 patients died who were operated on within 12 hours of the attack. For the next 12 hours, the mortality was 6 per cent. For the following 24 hours, it was 10.5 per cent. It is interesting to note that after the third day the mortality did not increase any further, an observation deviating from other statistics and probably ascribable to the preoperative treatment.

TABLE III.—THERAPY IN 38 NONSURGICAL PATIENTS WITH SMALL BOWEL OBSTRUCTION

	No.	*Deaths*
Obstruction spontaneously relieved	16	0
Obstruction relieved by barium enema	12	0
Condition too poor for operation	9	9
Refused operation	1	1
Total	38	10

In Table VII, the results are divided into two periods. For the last period of 11 years, the over-all mortality rate was 8.9 per cent, and for the surgical cases it was 7.2 per cent.

The nature of the obstruction in the patients operated upon is seen from Table VIII. Simple band obstruction does not have a higher mortality rate than obstruction caused by adhesions. When strangulation occurs the mortality is increased by more than 4 times.

Table IX shows the influence of a previous laparotomy on the mortality. The mortality rate is just half as much as in patients who have not had a previous laparotomy; and the mortality rate is even lower in patients previously operated on for intestinal obstruction. The same fact has been stated by Koch and Krook.

The simplest explanation of this observation is that in these cases both patient and doctor are more aware of the possibility of intestinal obstruction, which fact results in earlier admission and treatment. In the

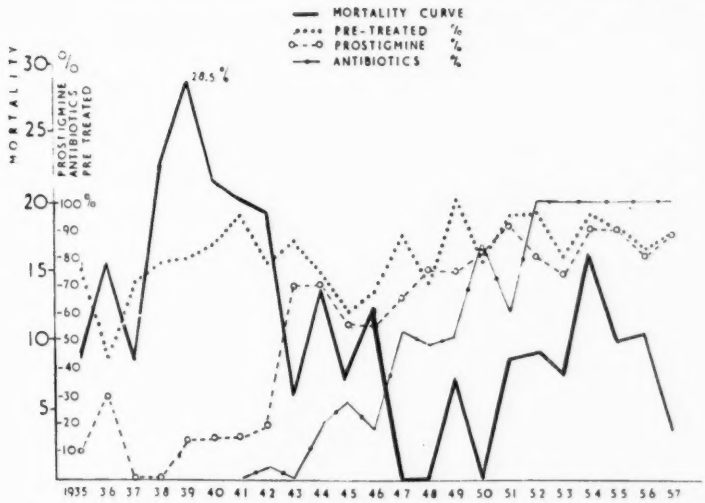

FIG. 1. Mortality curve, per cent pretreated, and per cent treated with prostigmine and antibiotics in 455 surgical patients with small bowel obstruction.

present series, 56 per cent of the patients were admitted within 24 hours after the onset of the symptoms: 43 per cent of the patients not previously laparotomized, 67 per cent of those previously laparotomized, and 73 per cent of those previously operated on for intestinal obstruction. This observation seems to support the theory mentioned.

The causes of death in the patients operated upon are summarized in Table X. Twenty-seven of the patients died from postoperative infections. Twenty-two of these occurred before the introduction of modern antibiotics (1946). In 5 of the fatal cases, the diagnosis was made too late. In all these cases, strangulation was present but both clinical and roentgenologic examinations at first failed to indicate the diagnosis. The operations were performed: 14, 20, 24, 47, and 48 hours after admission and in 3 cases on an incorrect diagnosis.

TABLE IV.—PREOPERATIVE ADMINISTRATION OF FLUIDS AND ELECTROLYTES TO 363 PATIENTS WITH SMALL BOWEL OBSTRUCTION

	No. cases
Normal saline solution (0.9 per cent)	204
Glucose (5 per cent)	48
Saline and glucose	86
Sodium bicarbonate (1.3 per cent) and saline	4
Sodium bicarbonate in combination with glucose, dextran, or Darrow's solution	5
Blood or plasma	16
Total	363

DISCUSSION

Table XI shows the mortality in relation to the duration of the disease at admission. The earlier the patient is admitted, the better the prognosis. One hundred and seventy-two patients were admitted within 12 hours after the onset of the attack, and the mortality rate was 5.3 per cent. But only 60 were operated on within 12 hours after the start. Among these patients, there was no mortality (Table VI). Early diagnosis is thus a *conditio sine qua non* for a good result. Here the roentgen examination is decisive. Roentgen examination gives the correct

TABLE V.—ANESTHESIA IN 455 SURGICAL PATIENTS WITH SMALL BOWEL OBSTRUCTION

	No.	*Deaths*
Spinal anesthesia	227	21
N_2O-ether anesthesia	165	13
Ether	32	6
Local anesthesia and ether	6	3
Cyclopropane	1	1
No anesthesia (newborn babies)	2	1
No information	22	2
Total	455	47

TABLE VI.—OPERATIVE PROCEDURES IN 455 PATIENTS WITH SMALL BOWEL OBSTRUCTION CLASSED ACCORDING TO DURATION OF DISEASE AT OPERATION

	Hours after onset								
Operation	*0*	*12*	*24*	*48*	*72*	*96*	*Later*	*Uncertain*	*Total*	*Mortality, per cent*
Lysis adhaerentium	48	82	72	33	19		43	30	327	
Deaths	0	4	4	2	1		5	2	18	5.7
Lysis and ext. Meckel's div.	2	1	4	3	2		0	1	13	
Deaths	0	0	0	1	2		0	0	3	23.0
Lysis and anastomosis	2	5	2	0	1		7	2	19	
Deaths	0	0	0	0	1		3	1	5	26.3
Primary resection	2	8	14	5	2		2	2	35	
Deaths	0	0	5	3	0		1	1	10	28.5
Ileostomy	0	2	3	3	0		3	3	14	
Deaths	0	1	2	1	0		1	2	7	50.0
Enterotomy (gallstones)	0	1	1	0	1		2	0	5	
Deaths	0	0	0	0	0		1	0	1	20.0
Desinvagination	2	1	3	1	2		2	2	13	
Deaths	0	0	0	1	0		0	0	1	7.7
Detorsion	0	8	2	2	0		3	0	15	
Deaths	0	2	0	0	0		0	0	2	13.3
Laparotomy and "milking"	4	7	5	0	0		0	0	14	
Deaths	0	0	0	0	0		0	0	0	00.0
Total	60	115	104	47	27		62	40	455	
Deaths	0	7	11	8	4		11	6	47	
Mortality, per cent	0	6.1	10.5	17.0	15.0		17.7	15.0	10.3	10.3

diagnosis in 95 per cent of cases involving the small bowel and in practically 100 per cent of cases of obstruction of the colon. One should not, of course, underestimate the importance of the clinical examination. It should especially be stressed that prolonged inspection and auscultation of the abdomen are of paramount importance. But it was clearly shown in this series that if roentgen examination failed, the correct diagnosis was delayed.

A comparison of the mortality rates with the use of preoperative treatment, prostigmine, and antibiotics is shown in Figure 1. Preoperative treatment of the patients with fluids and electrolytes surely contributed to the good results. From the mortality curve (Fig. 1), it is difficult to draw any definite conclusions on this point because the percentage of patients who received this treatment varied too little from one year to another. The importance of this measure is most distinctly seen in those patients who did not come to the hospital until late. In most statistics, the mortality rate is given as over 50 per cent after the lapse of the second day. In the present series, the over-all mortality rate on the third day was 21.3 per cent and 17 per cent for the patients operated upon, and it does not increase any further. This observation seems to point out that the preoperative treatment has improved the general condition of the patients to such an extent that even those with advanced cases had just as favorable a prognosis as those who had a history of 2 or 3 days.

Prostigmine postoperatively seems to have had a favorable effect. The routine use of prostigmine in the postoperative treatment was introduced in 1943. The mortality curve that year shows a sharp decline and remains later at a lower level (Fig. 1). The mortality rate in the patients who received prostigmine was less than one-half that of the patients who did not receive this agent (Table XII).

Another reason for the reduced mortality rate in the period of the last 11 years (Table VII) is the introduction of modern antibiotics. Complicating peritonitis, which was usually the most common cause of death,

TABLE VII.—MORTALITY IN 493 PATIENTS WITH SMALL BOWEL OBSTRUCTION IN TWO PERIODS (12 AND 11 YEARS)

	Total		Operated upon	
Period	*No.*	*Mortality, per cent*	*No.*	*Mortality, per cent*
1935–1946	234	17.5	219	13.7
1947–1957	259	8.9	236	7.2
Total	493	11.5	455	10.3

TABLE VIII.—NATURE OF OBSTRUCTION IN 455 SURGICAL PATIENTS WITH SMALL BOWEL OBSTRUCTION

Nature of obstruction	*No.*	*Deaths*	*Mortality, per cent*
Bands without strangulation	114	5	4.4
Bands with strangulation	81	16	20.0
Adhesions	155	11	7.1
Meckel's diverticulum	16	6	37.5
Incarceration in internal hernias	14	1	7.1
Volvulus	12	2	16.6
Intussusception	16	2	12.5
Gallstones	5	1	20.0
Alimentary obstruction	16	1	6.3
Intraperitoneal abscess	6	0	0
No information	20	2	10.0
Total	455	47	10.3

TABLE IX.—INFLUENCE OF PREVIOUS LAPAROTOMY IN 493 PATIENTS WITH SMALL BOWEL OBSTRUCTION

	No.	*Deaths*	*Mortality, per cent*
Previous laparotomy	318	27	8.5
No previous laparotomy	156	24	15.4
No information	29	6	20.7
Total	493	57	11.5

TABLE X.—CAUSES OF DEATH IN 455 SURGICAL PATIENTS WITH SMALL BOWEL OBSTRUCTION

	No. cases
Peritonitis	21
Shock	6
Paralytic ileus	3
Pneumonia	3
Pneumonia and peritonitis	1
Cardiac insufficiency	3
Pulmonary embolism	2
Abdominal wall inflammation	2
Acute pancreatic necrosis	1
Small bowel fistula	1
Lower nephron nephrosis	1
Poor general condition	1
Cannot be judged	2
Total	47

TABLE XI.—MORTALITY AND DURATION OF DISEASE AT ADMISSION IN 493 PATIENTS WITH SMALL BOWEL OBSTRUCTION

Duration of disease, hours	*No.*	*Deaths*	*Mortality, per cent*
1–12	172	9	5.3
13–24	115	12	10.4
25–48	71	9	12.7
49–72	33	7	21.3
73–96	17	3	17.7
Over 96	40	11	27.5
Uncertain	45	6	13.3
Total	493	57	11.5

TABLE XII.—PROSTIGMINE IN THE POSTOPERATIVE PERIOD AND MORTALITY IN 455 SURGICAL PATIENTS WITH SMALL BOWEL OBSTRUCTION

	No.	*Deaths*	*Mortality, per cent*
With prostigmine	280	18	6.5
Without prostigmine	148	25	16.9
No information	27	4	14.8
Total	455	47	10.3

has practically disappeared during this period.

Apart from a few cases of postoperative ileus, we did not dare treat acute mechanical obstruction with permanent suction via the Miller-Abbott tube. This method is considered inadvisable for the following reasons: Can suction remove a massive obstruction of the intestinal passage? We do not think so. Then what type of obstruction did those patients have in whom suction helped? Nobody knows. Probably it was a simple obstruction due to a kink or a slight torsion of the bowel. It might not have been mechanical obstruction at all.

In the present series, 123 cases are excluded, including 2 surgical, all of which had been classed as cases of intestinal obstruction, but for which we found the evidence to be insufficient for the diagnosis. These patients were both clinically and roentgenologically suspected of having intestinal obstruction. During the preoperative treatment, the symptoms disappeared in 121 cases. In the 2 surgical cases, no definite obstruction could be detected. All the patients left the hospital in good condition. If these patients had been treated by suction, this treatment would probably have been given the credit for the result. Becker has shown the bad prognosis in those cases in which suction failed to relieve obstruction.

CONCLUSIONS

Early diagnosis and treatment are the most important points in the management

of acute intestinal obstruction. The majority of the patients require preoperative treatment with fluids and electrolytes. The operation should be as simple as possible. Prostigmine treatment, which should be started immediately after operation, seems to be of great importance, as is the systematic use of modern antibiotics. Preoperative aspiration of the stomach and the upper part of the small bowel should not be performed with the aid of a Miller-Abbott tube but by means of an ordinary duodenal tube, which is easier to apply and causes less discomfort.

SUMMARY

Four hundred and ninety-three cases of acute small bowel obstruction are reviewed. The patients were seen in the period between 1935 and 1957 inclusive. The operative mortality rate for the first 12 years was 13.7 per cent and for the last 11 years 7.2 per cent.

The main principles for the treatment were: early diagnosis and treatment; replacement of the loss of fluids and electrolytes prior to operation; the simplest possible operation; systematic use of prostigmine and antibiotics in the postoperative period.

REFERENCES

1. Becker, W. F. Acute adhesive ileus; a study of 412 cases with particular reference to the abuse of tube decompression in treatment. Surg. Gyn. Obst., 1952, 95: 472.
2. Koch, F. Clinical and roentgenological studies of acute obstruction of small intestine due to adhesions and bands. Acta chir. scand., 1944, 90: 1–165.
3. Krook, S. S. The therapy of acute ileus. Transactions of Scandinavian Surgical Society. P. 78. Lund, Sweden: Berlingska Boktrykkeriet, 1953.

THE PROTECTIVE EFFECT OF KIDNEY HYPOTHERMIA ON TOTAL RENAL ISCHEMIA

PAUL R. SCHLOERB, M.D., F.A.C.S., RICHARD D. WALDORF, M.D., and JOHN S. WELSH, M.D., Kansas City, Kansas

THE PROTECTIVE EFFECT of general hypothermia on renal vascular occlusion has been established as reported by Moyer and associates. Preservation of kidney function after 2 hours and 6 hours of renal ischemia by local cooling to 20 degrees C. and to 10 to 15 degrees C., respectively, has been documented by Bogardus and by Moyer and their associates. Tissue metabolism and oxygen requirement should be decreased in proportion to the lowering of temperature, thereby prolonging the permissible period of ischemia. In this article are presented an experimental evaluation of this hypothesis and extension of our previous findings (5).

MATERIALS AND METHODS

Thirty-four male and female dogs varying in weight from 15 to 22 kilograms were used for this study; sodium pentobarbital anesthesia was used (30 mgm. per kgm. with supplementary amounts as necessary). The protective effect of cooling *in situ* on renal ischemia was studied in 15 dogs. After a right nephrectomy, the left kidney was freed upward and the renal artery, vein, and ureter were isolated and clamped with atraumatic arterial bulldog clamps after injection of 20 milligrams of heparin into the renal artery. Then, the kidney was placed in a sterile polyethylene bag and tied around the pedicle with inversion of the bottom of the sac so that the kidney would be cooled to 2 to 4 degrees C. but would not be in direct contact with ice water placed in the bag (Fig. 1). Occlusion times were varied from 1 to 12 hours when the clamps and bag were removed; the abdomen was closed; and the animal was allowed to recover. Kidney and rectal temperatures were taken in 2 acute tests, in which a thermistor was inserted into the kidney parenchyma.

Nineteen dogs were used to study the effects of cooling of a kidney removed with subsequent autotransplantation in the iliac fossa by the method of Murray and co-

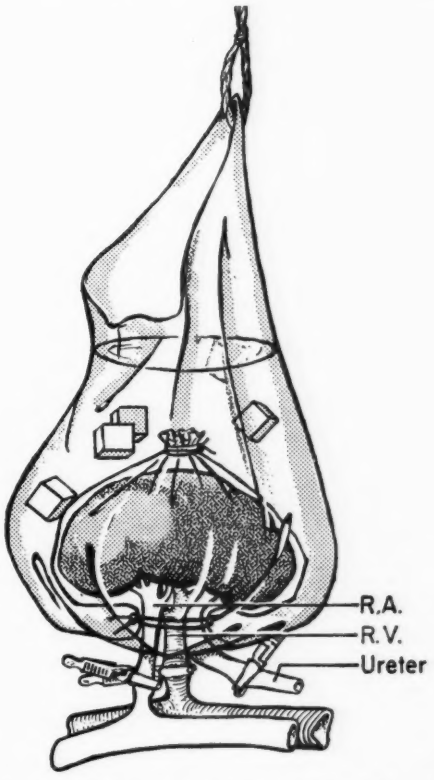

FIG. 1. The kidney is invaginated into the tied end of the plastic bag which is filled with ice water. All pedicle structures are occluded.

From the Department of Surgery, University of Kansas School of Medicine, Kansas City, Kansas.
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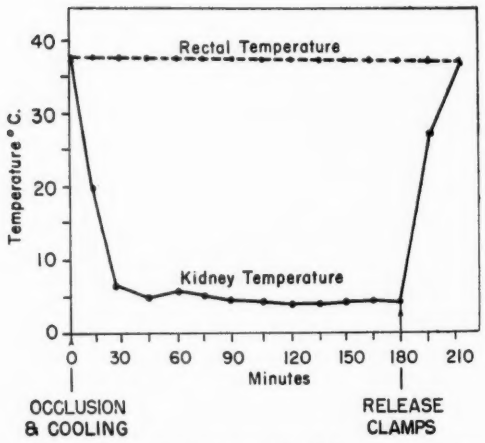

FIG. 2. Maintenance of normal body heat with changes in kidney temperature during ischemia and cooling.

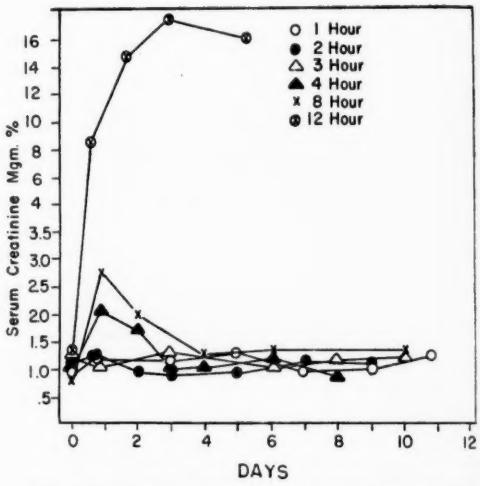

FIG. 3. Correlation of creatinine and vascular occlusion time, indicative of extent of renal damage, is evident.

workers. After removal, the left kidney was stored in a sterile jar at 0 degrees C. for 2, 4, or 24 hours. Contralateral nephrectomy was performed initially in all but the dogs with 24 hour kidney cooling, in which nephrectomy was delayed for 3 to 6 weeks.

Plasma creatinine concentrations, urine volume, and urine specific gravity were used as indices of renal function. Autopsies were done on all animals.

RESULTS

Direct measurement of kidney and rectal temperatures showed that the body tem-

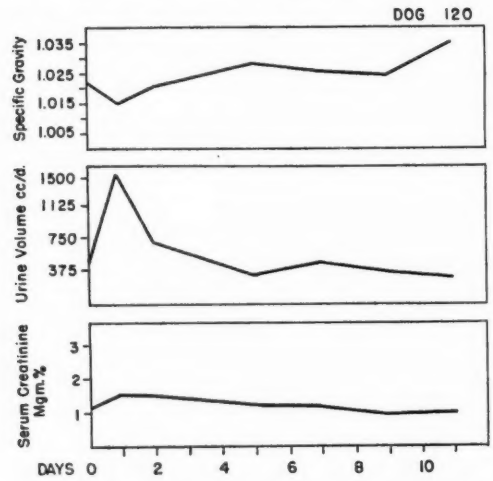

FIG. 4. Four hour renal occlusion with *in situ* cooling to 5 degrees C. and contralateral nephrectomy. Normal creatinine concentration and other indices of renal function are maintained. Diuresis occurs at 24 hours.

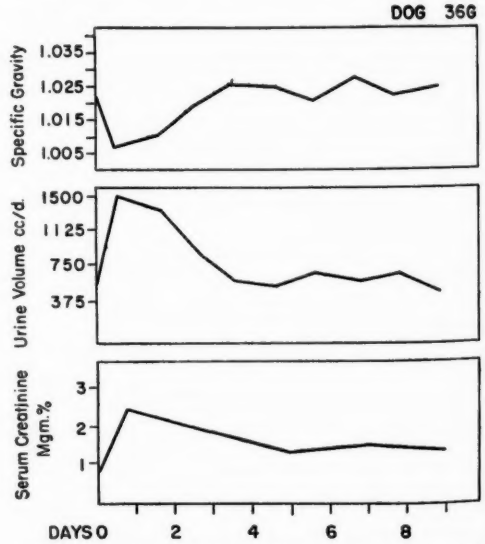

FIG. 5. Autotransplant of kidney removed and cooled in vitro to 5 degrees C. for 4 hours with contralateral nephrectomy. Early evidence of renal damage with return to normal values are shown.

FIG. 6. Section of the dog kidney 6 weeks after removal, cooling for 24 hours, and autotransplantation. Glomeruli are easily identified and the tubules contain protein material but epithelial structures are preserved. × 122.

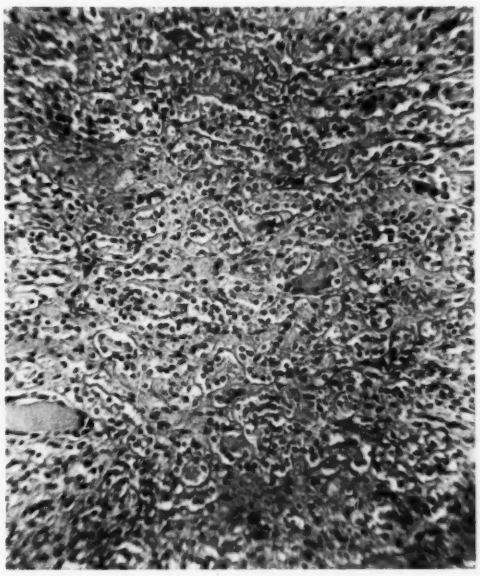

FIG. 7. Another area of the kidney shown in Figure 6. Protein-containing fluid in the tubules with preservation of epithelial structures are evident in this photomicrograph. × 122.

perature was maintained at 37 degrees C. during cooling of the kidney for 3 hours at 4 degrees C. (Fig. 2).

Results are summarized in Table I and Figure 3. All dogs with contralateral nephrectomy, total renal ischemia, and kidney cooling, *in situ* for periods up to 8 hours in the manner described, recovered completely. Animals in the 1, 2, and 4 hour groups showed no significant elevation of plasma creatinine concentration (maximum 1.2 mgm. per cent). Diuresis for 24 hours occurred in the 4 hour group (Fig. 4). Ischemia-cooling for 8 hours was followed by a transient increase of the plasma creatinine to 2.8 milligrams per cent on the following day with return to normal (1.2 mgm. per cent) accompanied by profuse diuresis. All of the animals in the 12 hour *in situ* ischemia-cooling group were anuric and died with uremia in 4 to 6 days. Histologically the kidneys showed extensive hemorrhage and areas of infarction. No histologic alteration of the normal kidney architecture was observed in animals with ischemia-cooling for periods up to 8 hours.

Although increasing experience reduced the incidence, in a high proportion of the animals with autotransplantation of a removed and cooled kidney vascular thrombosis developed. One dog (Fig. 5) with 4 hour cooling of a removed kidney, auto-

TABLE I.—EFFECT OF RENAL ISCHEMIA AND COOLING TO 5 DEGREES C. ON FUNCTIONAL SURVIVAL

Cooling and ischemia time	*No. of dogs*	*Type of cooling*	*Serum creatinine, mgm. per cent*	*End results*
I 1 hour	2	In situ	1.0–1.4	Survival
II 2 hour	3	In situ	1.2–1.4	Survival
III 3 hour	3	In situ	1.0–1.2	Survival
IV 4 hour	2	In situ	.8–1.2	Survival
V 4 hour	2	Auto-transplant	1.0–2.2	Survival (1) Venous thrombosis (1)
VI 8 hour	2	In situ	1.0–2.8	Survival
VII 12 hour	4	In situ	1.0–19.0	Anuria, death
VIII 24 hour	16	Auto-transplant	1.0–20.0	Anuria, death Vascular thrombosis (10)

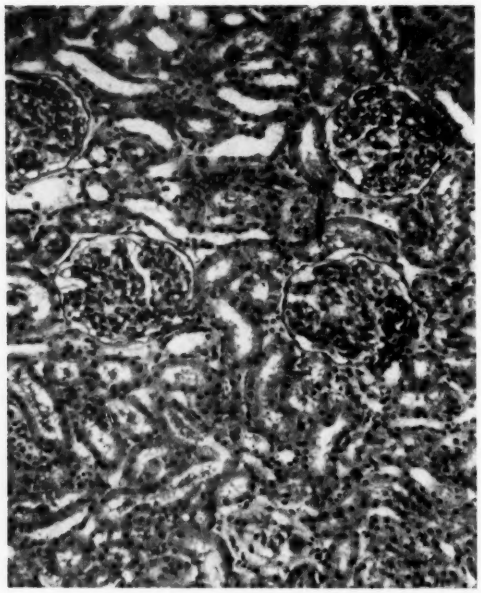

FIG. 8. Section of kidney 14 months after ischemia-cooling *in situ* for 8 hours, with contralateral nephrectomy. Focal pyelonephritis and occasional casts are present. × 122.

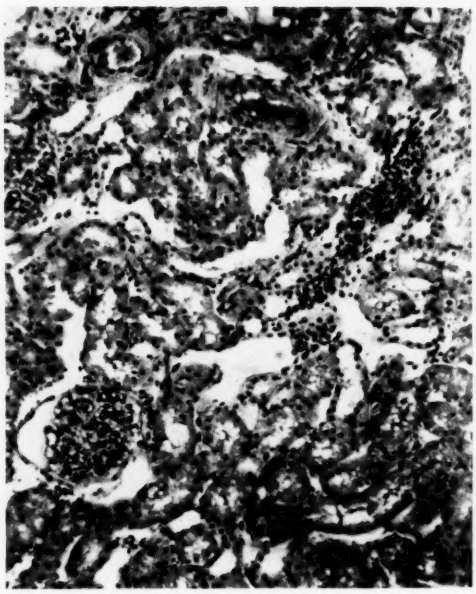

FIG. 9. Section of kidney 14 months after removal, cooling for 4 hours, autotransplantation, and contralateral nephrectomy. Focal areas of pyelonephritis, blood vessel thickening, and occasional hyaline casts. × 122.

FIG. 10. Intravenous urogram, 14 months after removal, cooling for 4 hours, autotransplantation to left iliac fossa, and contralateral nephrectomy. Hypertrophy, good concentration, and bladder-filling without obstruction seen.

transplantation, and contralateral nephrectomy recovered completely with slight elevation of the plasma creatinine (2.2 mgm. per cent) and diuresis for 24 hours and is normal 1 year later. In the other dog used for a similar procedure immediate vascular thrombosis developed and the animal died with uremia. In 10 of 16 dogs with 24 hour cooling of a removed kidney and autotransplantation, vascular thromboses developed, and they died with anuria and uremia after removal of the contralateral kidney 3 to 6 weeks later. One animal in this group had an essentially normal-appearing transplanted kidney at autopsy 6 weeks later with evidence of recent vascular thrombosis. Direct biopsy of this kidney done earlier at the time of contralateral nephrectomy showed readily identifiable kidney architecture.

After 14 months, 1 animal with 8 hour ischemia cooling *in situ* and 1 (36G) with 4 hour kidney removal, cooling to less than 5 degrees C., and autotransplantation (both

with contralateral nephrectomy) appeared normal and had lost no weight. Hematocrit concentrations were 52 per cent and 50 per per cent, respectively. Plasma concentrations of sodium, potassium, calcium, magnesium, and chloride were normal. Concentrations of creatinine were 1.2 and 1.1 milligrams per cent while urea nitrogen values were 24.4 and 17.9 milligrams per cent, respectively. Endogenous creatinine clearance values were 62.4 and 54.5 milliliters per square meter (normal to 90 ml. per square meter with two kidneys). Intravenous urogram of the autotransplant (Fig. 10) showed good concentration without obstruction. Blood pressure was not measured. The kidney was removed from each of the animals and weighed 57 and 71 grams respectively. Sections (Fig. 8) of the kidney with 8 hour ischemia-cooling showed focal areas of pyelonephritis and occasional casts with pigmentation in some of the tubular cells. Histologic study (Fig. 9) of the kidney previously ischemic, cooled for 4 hours and autotransplanted, showed focal areas of pyelonephritis, blood vessel thickening, and occasional hyaline casts. No pigmentation in tubule cells was observed.

DISCUSSION

Studies by Oliver indicate that the renal tubules sustain the major damage in the ischemic kidney, and steps in the repair process of this type of renal damage involve restoration of morphologic and functional integrity of the tubular units. Transient diuresis, occurring in our animals with ischemia-cooling for 4 to 8 hours, is interpreted as evidence of tubular damage, while anuria accompanying longer ischemia-cooling suggests glomerular damage as well.

Although none of the animals with local kidney cooling to 0 to 5 degrees C. for over 8 hours survived after removal of the contralateral kidney, the finding of preservation of kidney structures histologically in 1 animal 6 weeks after removal, cooling to 0 degrees C. for 24 hours, and autotransplantation suggests that it may be possible to prolong this ischemia-cooling further.

The protection afforded by cooling to 20 to 25 degrees C. was reported by Stueber and associates to be increased by cooling to 10 to 15 degrees C., with 75 per cent survival from renal artery and vein occlusion but not from ureteral occlusion for 6 hours in this temperature range. Our results suggest that further protection is afforded by lower temperatures. The permissible time for ischemia under these conditions suggests its use for protection of the donor kidney in renal transplantation between identical twins and its possible future application in homotransplantation. Surgery involving temporary renal vascular occlusion is a possible application of this technique. Use during an operative procedure should be feasible, and it may afford greater protection to the kidney than general hypothermia at the temperatures of about 25 degrees C. commonly employed.

SUMMARY

The protective effect of local kidney cooling to 0 to 5 degrees C. for periods up to 24 hours was evaluated experimentally *in situ* and by nephrectomy with cooling of the removed kidney and autotransplantation with contralateral nephrectomy. Survival and restoration of normal kidney function followed ischemia-cooling for up to 8 hours.

REFERENCES

1. Bogardus, G. M., and Schlossen, R. The influence of temperature upon ischemic renal damage. Surgery, 1956, 39: 970.
2. Moyer, J. H., Morris, G., and DeBakey, M. E. Hypothermia; effect on renal hemodynamics and on excretion of water and electrolytes in dog and man. Ann. Surg., 1957, 145: 26.
3. Murray, J. E., Lang, S., Milles, B. W., and Dammis, G. J. Prolonged functional survival of renal autotransplants in the dog. Surg. Gyn. Obst., 1956, 103: 15.
4. Oliver, J., MacDowell, M., and Tracy, A. Pathogenesis of acute renal failure associated with traumatic and toxic injury. J. Clin. Invest., 1951, 30: 1305.
5. Schloerb, P. R., Waldorf, R. D., and Welsh, J. S. The protective effect of kidney hypothermia on total renal ischemia. Surgical Forum; Clinical Congress 1957. Vol. VIII, p. 633. Chicago: American College of Surgeons, 1958.
6. Stueber, P. J., Jr., Kovacs, S., Koletsky, S., and Persky, L. Regional hypothermia in acute renal ischemia. J. Urol., Balt., 1958, 79: 793.

TRAUMATIC AORTIC-RIGHT VENTRICULAR FISTULA

NICHOLAS P. D. SMYTH, M.B., PAUL C. ADKINS, M.D., GEORGE A. KELSER, M.D., and JUAN CALATAYUD, M.D., Washington, District of Columbia

THE MOST COMMON CAUSE of a fistula between the aorta and right ventricle is rupture of a congenital or acquired aneurysm of the right sinus of Valsalva. The occurrence of such a communication due to a penetrating wound of the heart is exceedingly uncommon. A review of the literature discloses only 3 similar cases, those reported by King and Morris and their associates. In view of the rarity of such a fistula, we wish to record the details of this additional case.

CASE REPORT

On October 4, 1958, at approximately 5:00 a.m., a 22 year old negro male was stabbed in the chest with a short, straight knife. Blood stains on the street indicated that he then walked 1 block, but the patient has no recollection of doing this. He was found in a parked car by the police who took him to The District of Columbia General Hospital.

Examination at 7:10 a.m. revealed an acutely ill negro male who was unconscious, respirations were slow and irregular, and there was marked pallor of the palms and soles. Blood pressure was unobtainable although very faint femoral artery pulsations could be palpated. The jugular veins were distended. A 1.5 centimeter stab wound was noted in the third intercostal space just to the left of the sternum. Heart sounds were faint. The liver was not palpably enlarged.

Intravenous fluids were started, and a subxiphoid pericardiocentesis was performed. During the pericardiocentesis the patient stopped breathing. An airway was inserted, and intermittent positive pressure oxygen was given by mask. After the removal of 40 cubic centimeters of dark blood from the pericardial sac, the respirations resumed and the femoral pulses became stronger. A thoracentesis was performed in the left fifth intercostal space, but no blood or air was obtained. At 7:30 a.m. the venous pressure was 270 millimeters of saline, and an arterial pressure of 100 millimeters of mercury was obtained by palpation.

The patient was then taken to the operating room. After induction of anesthesia and insertion of an endotracheal tube, the stab wound began to bleed vigorously. The chest was promptly entered through an anterior incision in the left fourth intercostal space. The third and fourth costal cartilages were divided close to the sternum for additional exposure. The blood pressure at this time was 50/0 millimeters of mercury. The internal mammary vessels were found to be severed and were secured with suture ligatures of No. 00 black silk. Approximately 1,000 cubic centimeters of liquid and clotted blood were removed from the left side of the chest. The tense pericardium was widely incised, and approximately 200 cubic centimeters of liquid and clotted blood were removed from the pericardial sac. The heart action became very vigorous, and the blood pressure rose to 150/50 millimeters of mercury. This caused a profuse fresh hemorrhage from the heart. The heart was then dislocated from the pericardial sac and a 1.5 centimeter laceration was located in the infundibulum of the right ventricle extending distally to the pulmonic valve ring (Fig. 1). The laceration was closed with a continuous No. 00 black silk suture. The heart was then returned to the pericardial sac and pericardium partially closed inferiorly.

From the Department of Surgery and the Department of Medicine, The George Washington University Hospital and The District of Columbia General Hospital, Washington, D. C.

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A coarse, continuous thrill was noted to be present in the area of the right ventricular wound and was interpreted as probable evidence of injury to the pulmonic valve. In view of the considerable dilatation of the heart, the patient was given 0.8 milligram of cedilanid intravenously. The chest was closed with drainage. While the wound was being closed, it was noted by the anesthesiologist that, although the systolic blood pressure was stable at 120 millimeters of mercury, the diastolic pressure ranged from 0 to 20 millimeters of mercury. The thrill in the area of the cardiac wound and the low diastolic pressure suggested the diagnosis of a traumatic aortic-right ventricular fistula. A roentgenogram of the chest taken in the upright position with a portable machine immediately after operation showed satisfactory expansion of the left lung. The patient was sent to the recovery room in good condition, awake and with no evidence of neurologic impairment.

Digitalization was completed as rapidly as possible and fluids were restricted, but the patient's condition deteriorated during the next 6 hours. During this period there was a coarse, palpable thrill in the area of the stab wound and a grade V continuous murmur audible over the entire precordium, maximal in the third interspace to the left of the sternum. In addition, the patient had a tachycardia, water-hammer peripheral pulses, an arterial diastolic pressure of 0, elevated venous pressure, and an enlarged liver palpable 5 fingers below the right costal margin.

After completion of digitalization in the next 18 hours, the patient's condition improved. Blood pressure was stable at 120/20 millimeters of mercury, pulse 110, venous pressure 90 millimeters of saline. The lungs were clear and the liver was no longer palpable. He improved steadily and 10 days later was transferred to The George Washington University Hospital for further study and elective repair of the intracardiac fistula.

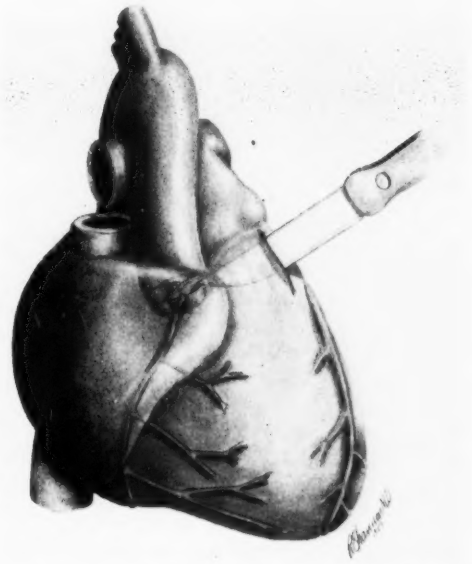
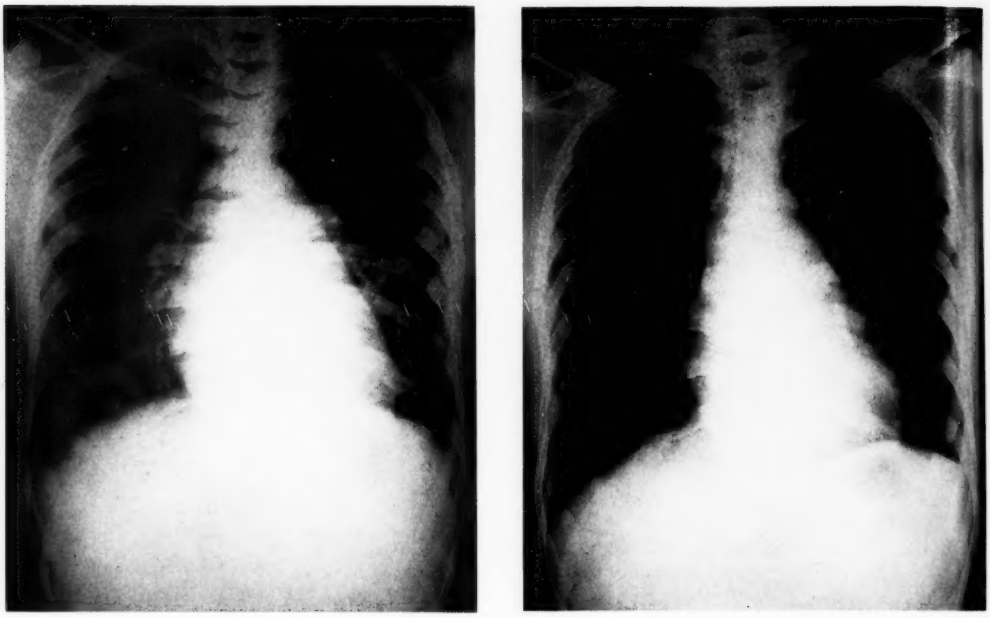


FIG. 1. Drawing of heart in the right anterior oblique projection. The knife wound in the infundibulum of the right ventricle extends to the pulmonic valve ring. The tip of the knife has entered the root of the aorta in the region of the right sinus of Valsalva.

At this time the patient was ambulatory, afebrile, and experienced mild exertional dyspnea. The stab wound and surgical incision were well healed. There was still a loud, continuous murmur maximal in the second and third intercostal spaces to the left of the sternum. Blood pressure was 120/30–50 millimeters of mercury. Electro-

TABLE I.—CARDIAC CATHETERIZATION DATA

	Pressures, mm. Hg.				*Nitrous oxide test, per cent*					*Oxygen content*							
	PA	*RV*	*RA*	*PC*	*PA*	*High RV*	*Low RV*	*RA*		*BA*	*PA*	*High RV*	*Low RV*	*Low RA*	*Mid RA*	*High RA*	*SVC*
10-21-58	40	40	7-8	—	59	66	24	26	Vol. per cent	14.3	11.1	12.5	6.3	4.9	5.7	5.3	4.7
Before closure of fistula	12	0-2	mean						Per cent sat.	98	79	85	54	42	48	45	40
12-17-58	20	20	3-4	<5	16	15	—	—				Not done					
After closure of fistula	5-0	0	mean		Normal values:												
					<20	<20	<20	<30									



a b

FIG. 2. Roentgenograms of the patient's chest: a, Three weeks after the injury and emergency cardiorrhaphy. Note the enlarged heart and increased pulmonary vascular markings. b, Two months after repair of the aortic-right ventricular fistula. The heart size and pulmonary vascular markings are normal.

cardiogram showed a normally directed mean QRS vector with an abnormally widened QRS-T angle and small ST vector, compatible with digitalis effect. A blood volume determination showed slight hypovolemia which was corrected by transfusion. The roentgenogram of the chest showed a left pleural effusion. A thoracentesis was performed and 550 cubic centimeters of serosanguineous fluid were removed. Then, a roentgenogram of the chest (Fig. 2a) showed some cardiomegaly with fullness of the left side of the heart and increased pulmonary vascular markings.

On October 21, 1958 catheterization of the right side of the heart was performed. The findings are summarized in part in Table I. Blood gas analyses, dye dilution curves (Fig. 3), and pulse contour studies (Fig. 4) all indicated a left to right shunt at the level of the right ventricular outflow tract. Blood pressure was 130/40 (Fig. 5).

On October 22, 1958, aortic valvulography was done using the technique described by Nelson, Molnar, Klassen and Ryan. This study was performed to determine whether or not the knife wound had involved the aortic valve with resultant aortic insufficiency. A No. 14 French catheter with a conical tip and a single side opening was passed through an opening in the right common carotid artery into the ascending aorta, to lie within 2 cubic centimeters of the aortic valve. Ninety per cent hypaque was injected through this catheter while the left common carotid artery was occluded by finger pressure. The angiogram showed simultaneous filling of the aorta and pulmonary artery and/or high right ventricle. No dye entered the left ventricle (Fig. 6). The diagnosis was an aortic-right ventricular fistula, but no aortic insufficiency.

On November 5, 1958, repair of the fistula was undertaken using extracorporeal circu-

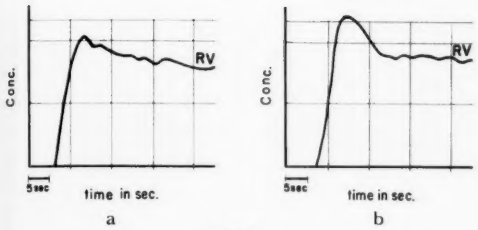


FIG. 3.

FIG. 3. Comparison of the indicator-dilution curves obtained from injection of T-1824 into right ventricle and sampling from brachial artery, before (a) and after (b) closure of the fistula. The early recirculation due to the left to right shunt is seen in the descending limb of the primary curve. The postoperative indicator-dilution curve is normal.

FIG. 4. Comparison of pressure pulse contours obtained with the catheter tip positioned high in the right ventricular outflow tract, before (a) and after (b) repair of the fistula. The deformity of the pressure pulse contour due to turbulence from the aortic-right ventricular shunt, evident in "a," was also present in the pulmonary artery but not in the low right ventricle. The pressure pulse contours were normal in all locations postoperatively.

FIG. 5. Comparison of the brachial artery pressure recordings before (a) and after (b) closure of the fistula.

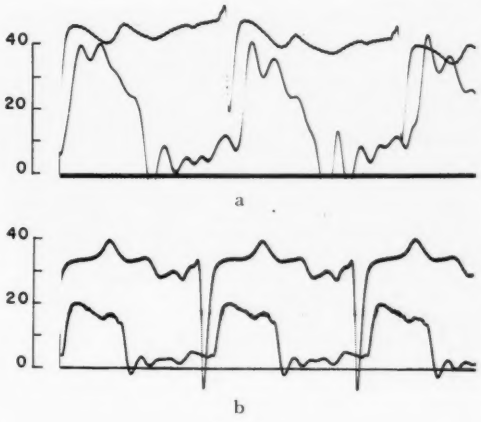


FIG. 4.

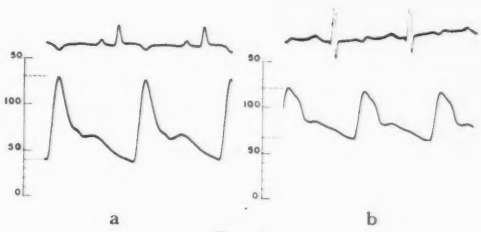


FIG. 5.

lation with a vertical screen oxygenator. Arterial and venous pressures as well as electroencephalogram and electrocardiogram were continuously monitored during the operative procedure. The chest was entered through a median sternotomy, and the pericardium was incised in the midline. The heart was bound to the pericardium by soft adhesions that were readily separated with the finger, except in the area of the previous stab wound where the suture line was densely adherent to the adjacent lung. It was noted that paradoxic dilatation of the right ventricular outflow tract occurred during systole. Heparin was administered and the appropriate cannulations of the superior and inferior vena cava and the right femoral artery were then made.

Cardiopulmonary bypass was instituted, and the fistula was occluded by compressing the right ventricular wall against it to prevent the loss of the cardioplegic agent into the right ventricle. The ascending aorta was cross clamped, and the heart was arrested by injecting potassium citrate into the root of the aorta. Cardiac arrest was achieved almost immediately, and a 6 centimeter cardiotomy incision was made in the right ventricle below the original stab wound. When the right ventricle was entered the fistula was immediately identified in the expected position. The communication was between the right sinus of Valsalva and the right ventricle. The opening measured 8 millimeters by 4 millimeters and had a firm endothelialized rim. The fistula was closed with 5 interrupted No. 00 black silk sutures (Fig. 7). The closure was checked for leaks by intermittent release of the aortic clamp. The aortic clamp was then removed, and the coronary blood and air were allowed to escape during closure of the ventriculotomy. After a few manual systoles, a normal rhythm was restored, and the extracorporeal

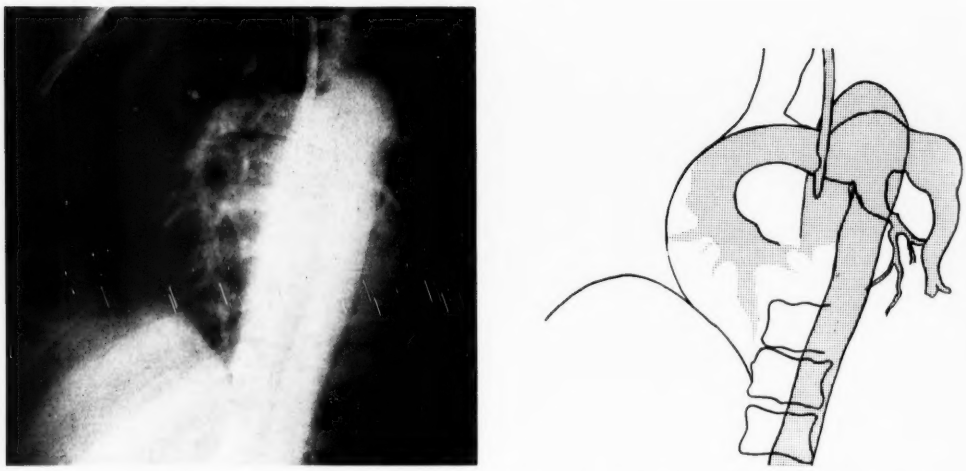


FIG. 6. In the film (1 second after start of injection) simultaneous opacification of the aorta and pulmonary artery occurred, demonstrating a shunt between the two systems approximately at the level of the aortic valve. No dye entered the left ventricle.

circulation was discontinued. The patient had had total by-pass for a period of 21 minutes. At this time a blood pressure of 120/80 millimeters of mercury was recorded on the monitor. The chest was closed in routine fashion with water-seal drainage to the right pleural cavity.

A roentgenogram of the chest taken in the upright position with a portable apparatus immediately after operation showed a left hemopneumothorax. A second catheter was inserted into the left pleural cavity for water-seal drainage. At the conclusion of the operation the patient was awake and in good condition. The remainder of the postoperative course was essentially uneventful.

The patient was discharged from the hospital on the fourteenth postoperative day. At this time he was active and asymptomatic. The single abnormal finding was a soft grade I diastolic murmur heard only in the left third intercostal space at the sternal border. He was readmitted on December 16, 1958, for catheterization of the right side of the heart. The findings are listed in part in Table I. There was no evidence of a residual shunt at this time (Figs. 3 and 4). The systemic pressure was 120/70 millimeters of mercury and the pulse contour was normal (Fig. 5). The patient has returned to work and remains entirely well. A roentgenogram of the chest taken in January 1959 shows a reduction in the heart size and essentially normal pulmonary vascular markings (Fig. 2b).

DISCUSSION

The initial management of this patient reflects our present policy in the treatment of heart wounds. The pericardiocentesis was done initially as an emergency therapeutic measure for cardiac tamponade. Inasmuch as this treatment did not afford complete relief, thoracotomy was performed as soon as possible. As a result, the exact anatomic site of the stab wound of the heart was established at operation. This knowledge was of considerable help in localization of the left to right shunt. Subsequent catheterization of the right side of the heart was done to confirm the clinical impression. This study, combined with the clinical findings of the continuous murmur and the low diastolic pressure made the diagnosis of aortic-right ventricular fistula in this patient certain.

At the time of the first cardiac catheterization the deformity of the pulse contour in the high right ventricle was due to turbulence from the left to right shunt. The pulse contour recorded at the same catheterization from the low right ventricle below the level of the jet was not deformed. Following closure of the fistula the pulse contour in the high right ventricle was normal in appearance (Fig. 4). A similar deformity of the intracardiac pulse contour has been noted in dogs with surgically created septal defects (7).

Aortic valvulography enabled us to rule out aortic insufficiency as a result of the injury. It was, therefore, unnecessary to open the aorta at the time of the second operation.

The fistula was oval in cross section; its long axis, surprisingly, was at right angles to that of the stab wound in the wall of the right ventricle. Possibly, the knife was twisted as it passed through the heart, or the long axis of the fistula may have been determined by the plane of attachment of the aorta to its valve ring. The anatomy of this area has been fully described by Edwards, and Bahnson has commented on the significance of the aortic attachment to the valve ring in determining the placement of sutures to close a defect in this region.

It was considered necessary to cross clamp the aorta during the period of open cardiotomy in view of the anatomic location of the shunt. Without cross clamping, the blood loss from the aorta would probably have been excessive. No difficulty was encountered in stopping the heart since the fistula was occluded by compressing the anterior wall of the right ventricle against it until the thrill was obliterated. In this way, there was no loss of potassium citrate into the right ventricle. King and Shumacker, in repairing a traumatic fistula, had considerable difficulty in arresting the heart, probably because of loss of the potassium solution through the fistula into the right ventricle. On the other hand, Lillehei and associates in their discussion of repair

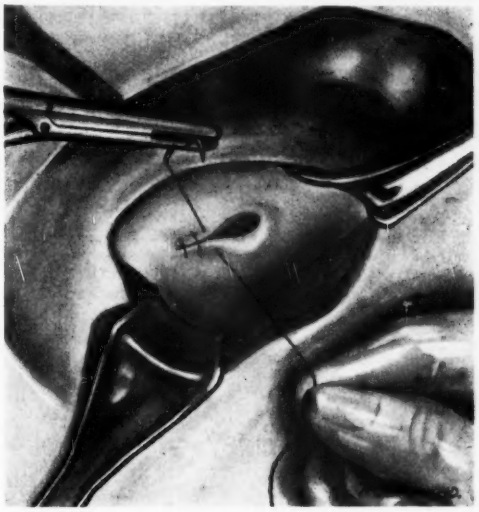


FIG. 7. Drawing showing the appearance of the fistula at operation. The long axis of the fistula is parallel to the plane of the aortic valve ring and at right angles to the long axis of the wound in the anterior wall of the right ventricle.

of ruptured aneurysms of the sinus of Valsalva do not mention any difficulty in obtaining cardioplegia in the 2 cases in which they used potassium citrate.

At the present time, we are inclined to agree with Morris and associates that cardiac arrest in this situation is probably unnecessary. The aorta can be cross clamped and the heart allowed to beat without any increased risk. The relatively small size of the defect and the firm, fibrous rim made closure with interrupted silk sutures quite simple, and the use of a patch or sponge prosthesis unnecessary.

SUMMARY

A case of traumatic aortic-right ventricular fistula is described. This is the fourth reported case to our knowledge. The diagnosis was made tentatively on the clinical findings after the initial operation for a stab wound of the heart and confirmed by physiologic studies. Successful closure of the fistula was achieved using extracorporeal circulation and elective cardiac arrest. Induction of cardiac arrest was fa-

cilitated by manual compression of the right ventricular wall against the fistula, and thus loss of the cardioplegic agent through the fistula into the right ventricle was prevented.

REFERENCES

1. Bahnson, H. Discussion of Lillehei (4).
2. Edwards, J. E., and Burchell, H. B. Specimen exhibiting the essential lesions in the aneurysm of the aortic sinus. Proc. Mayo Clin., 1956, 31: 407.
3. King, Harold and Shumacker, Harris B, Jr. Surgical repair of a traumatic aortic-right ventricular fistula. J. Thorac. Surg., 1958, 35: 734–739.
4. Lillehei, C. Walton, Stanley, Paul, and Varco, Richard L. Surgical treatment of ruptured aneurysms of the sinus of Valsalva. Ann. Surg., 1957, 146: 459–472.
5. Morris, George C., Jr., Foster, Riley P., Dunn, J. Ralph, and Cooley, Denton A. Traumatic aorticoventricular fistula; report of 2 cases successfully repaired. Am. Surgeon, 1958, 24: 883–888.
6. Nelson, S. W., Molnar, W., Klassen, K. P., and Ryan, J. M. Aortic valvulography and ascending aortography. Radiology, 1958, 70: 697.
7. Smyth, Nicholas P. D., Geoghegan, Thomas, and Lam, Conrad R. Experimental ventricular septal defect. Surg. Gyn. Obst., 1955, 100: 351–356.

A CLINICOPATHOLOGIC STUDY OF 43 CASES OF GLANDULAR TUMORS OF THE TONGUE

PAUL M. BURBANK, D.M.D., MALCOLM B. DOCKERTY, M.D., and
KENNETH D. DEVINE, M.D., F.A.C.S., Rochester, Minnesota

TUMORS OF GLANDULAR ORIGIN and composition are found not infrequently in or near structures confluent with the oral cavity. They can arise in connection with the lips, gums, tongue, floor or roof of the mouth, pharynx, larynx, and even the trachea. Histogenetically, they are usually ascribed to a source in salivary and mucous glands which occur in abundance about the head and neck. They rarely occur on the tongue, however. The dearth of information regarding glandular tumors of the tongue, and the fact that what little information we do have still confusingly tends to identify this group of neoplasms with mixed tumors, prompted the present investigation. Our purpose, therefore, is to sift the existing information regarding oral glandular tumors in general, and to add to this our own knowledge gained from experience with these neoplasms as they affect primarily the tongue.

GENERAL CONSIDERATIONS

Cylindromas. The term "cylindroma" was first used by Billroth in 1856. He described the neoplasm as an encapsulated orbital growth of glassy, translucent appearance. Microscopically, two systems of cylinders were described: one of epithelial cells making up the parenchymal portion of the tumor, and the other a matrix of cylinders or strands composed of hyaline or myxomatous connective tissue surrounding the former. A mucin-like material is sometimes found enclosed within the cylinders of epithelial cells. This secretion has been reported as being mucicarmine-positive by LeMaitre. However, McDonald and coworkers (15) found that some of the secretion was mucicarmine-positive while some was not. They suggested that the appearance of the honeycombed cylinders of epithelial cells resembled that of Swiss cheese. Sometimes these honeycombed spaces appeared to be empty and at other times they were filled with a hyaline substance instead of with mucus.

Volkmann, in 1895, expressed the view that cylindromas are of endothelial origin. Krompecher, however, likened them to basal cell carcinomas of the skin. Bauer and Fox proposed that cylindromas arise from the myoepithelial or basket cell, a contractile cell found in the salivary, lacrimal, and mucous glands.

Throughout the literature as well as in the original cataloguing of our own series, this tumor has been confused with the ordinary type of "mixed" tumor of the salivary gland, a neoplasm that reportedly very seldom, if ever, metastasizes. Mulligan, in his review, reported on 12 metastasizing mixed tumors; however, most of the illustrations in his article duplicate the microscopic appearance of cylindroma in all major features, according to Quattlebaum and co-workers.

Mucoepidermoids. Mucoepidermoid tumors constitute a distinct group of neoplasms of the salivary glands. They are regarded as originating from mucous or salivary glandular ducts, and they are composed of two main types of epithelial cells, namely a mucus-secreting glandular element and a squamous or epidermoid component. In addition, many of these tumors contain large hydropic or clear cells, not productive

From the Sections of Dentistry and Oral Surgery, Surgical Pathology, and Plastic Surgery, Mayo Clinic, and the Mayo Foundation, Rochester, Minnesota.

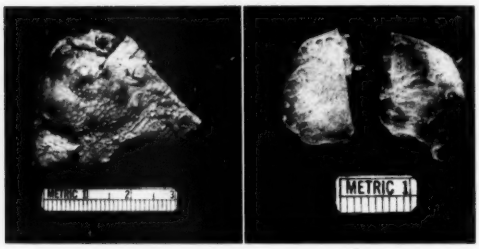


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FIG. 1. Typical gross appearance of a glandular tumor of the tongue in its usual location near the base. a, Outer surface showing bosselations. Ulceration is absent. b, Cut surface of an "ordinary" lingual adenocarcinoma showing infiltrative tendencies and lack of encapsulation.

of mucus, and certain smaller cells frequently referred to as being of "intermediate" or "basal" type. Stewart and associates, in 1945, chose the term "mucoepidermoid" to emphasize the two main histologic features of these tumors. Buxton and associates classified mucoepidermoid tumors of the salivary glands into malignant and benign categories. Foote and Frazell, on the other hand, expressed the view that strict separation into benign and malignant groups was too sharp. Woolner and coworkers divided mucoepidermoid tumors into two general groups on the basis of their histologic patterns. The lesions they called "mucoepidermoid tumors" had not metastasized, whereas the tumors that they named "mucoepidermoid carcinomas" behaved as rather high grade carcinomas.

Adenocarcinomas. This ordinary type comprises a group of glandular neoplasms occasionally seen involving the structures of the oral cavity and the salivary glands. Watson, in his series of 41 cases of intraoral adenocarcinoma, found that 17 per cent of the tumors involved the base of the tongue. Many of these adenocarcinomas exhibit a papillary architecture similar to that of the aberrant thyroid tumors studied by King and Pemberton. McDonald and Havens (14) separated papillary adenocarcinomas from other adenocarcinomas, stating that the latter group probably represented several unrelated types of malignant neoplasms.

Mixed tumors. These common salivary glandular neoplasms feature two essential histologic components, namely epithelial elements arranged in solid masses, strands, or alveoli, and "mesothelial" elements arranged in the form of hyaline cartilage, mucous tissue, or immature fibrous connective tissue. McFarland (16), in 1926, considered mixed tumors to be benign, but 7 years later, he concluded that they were often malignant. This change in concept of the behavior and nature of mixed tumors by the same investigator is a reflection of the change in trend of thought of many other writers with regard to this neoplasm. The inclusion of cylindromas in reported series of mixed tumors has further compounded the problem of classification. Although the histogenesis of mixed tumors is still not understood, the several favored theories still have their supporters. According to these theories, these tumors arise from: (1) embryonal rudiments by "enclavement," the most probable source being that of material from the branchial arches, (2) mesenchymal tissue, (3) epithelial tissue that forms the glands, (4) so-called ectomesodermal rests or (5) endothelium (Cheyne and co-workers). Dockerty and Mayo (7) described the lack of unanimity of opinion regarding the nature of these neoplasms by stating: "In an analysis of the array of conflicting evidence extant on the subject of 'mixed salivary gland tumors,' one is almost led to the conclusion that the word 'complicated' should have been used as a designation for these neoplasms."

PERTINENT LITERATURE

Whereas the literature is replete with testimony on the subject of glandular tumors of the head and neck in general, mention of this class of neoplasm occurring in the tongue is extremely rare. Significantly, reports by Dockerty and Mayo (8) and Lampe have indicated that lingual cylindromas may be dangerous from the standpoint of metastasis. Owen, in a study of lingual lesions with specific reference to their loca-

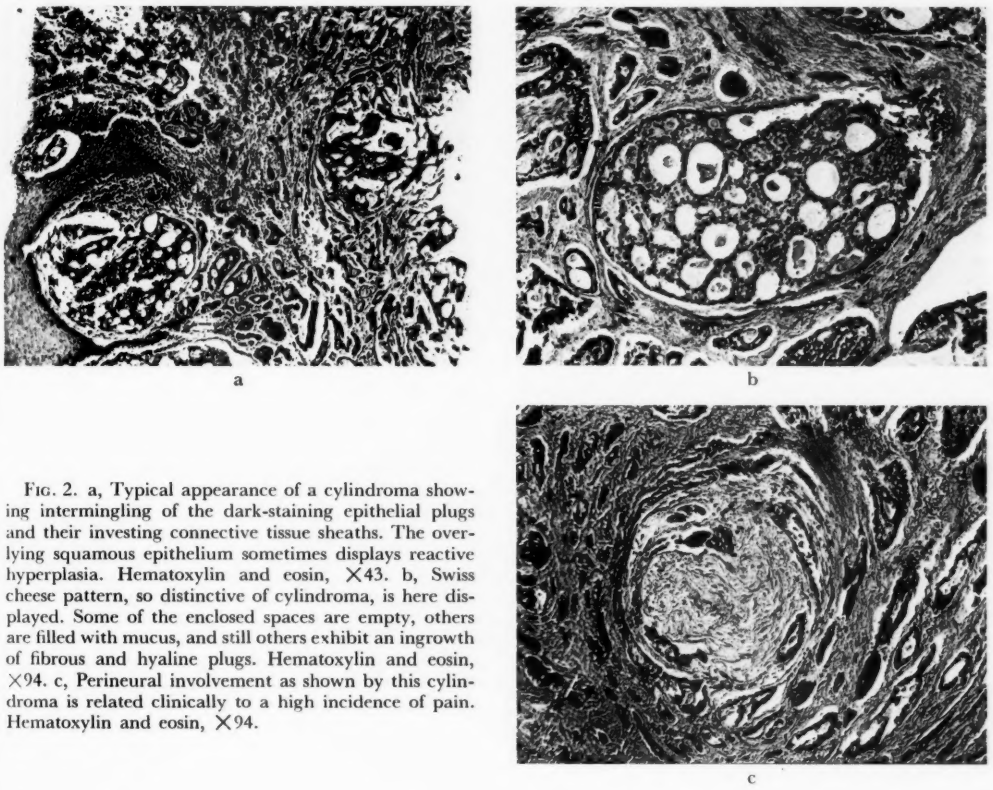

FIG. 2. a, Typical appearance of a cylindroma showing intermingling of the dark-staining epithelial plugs and their investing connective tissue sheaths. The overlying squamous epithelium sometimes displays reactive hyperplasia. Hematoxylin and eosin, ×43. b, Swiss cheese pattern, so distinctive of cylindroma, is here displayed. Some of the enclosed spaces are empty, others are filled with mucus, and still others exhibit an ingrowth of fibrous and hyaline plugs. Hematoxylin and eosin, ×94. c, Perineural involvement as shown by this cylindroma is related clinically to a high incidence of pain. Hematoxylin and eosin, ×94.

tion, found that tumors of the adeno-cell type constituted less than 2 per cent of all carcinomas of the tongue. Bell stated that very few adenocarcinomas were found on the tongue, and he made no mention of the so-called mixed tumor of this structure. Attesting to the extreme rarity of reported cases of true mixed tumor of the tongue, a review of the existing literature yields but 13 such cases. Cylindroma (adenocarcinoma, cylindroma type) likewise has seldom been reported as occurring on the tongue, there being only a few scattered case reports. We have been unable to come upon any comprehensive studies based on sizable series of lingual cylindromas. The literature appears to be silent about the occurrence of lingual mucoepidermoid tumors, although one of us (M.B.D.) previously observed material from such a case.

Scattered reports include statements relating to the occurrence of ordinary adenocarcinoma involving the tongue. The article by Watson is pertinent, and the predilection of the lingual base for the occurrence of the neoplasms brings up the problem of distinguishing them from such lesions as thyroglossal cysts and lingual thyroid nodules.

MATERIAL AND METHOD

The pathologic records of all patients seen at the Mayo Clinic for the years 1906 through 1957 who had suffered from either malignant or benign lesions of the tongue were reviewed. The records of those tumors of a glandular nature found on the tongue were withdrawn and further reviewed and analyzed from the clinical, surgical, and pathologic standpoints. From a total of more than 3,800 cases, 60 were further in-

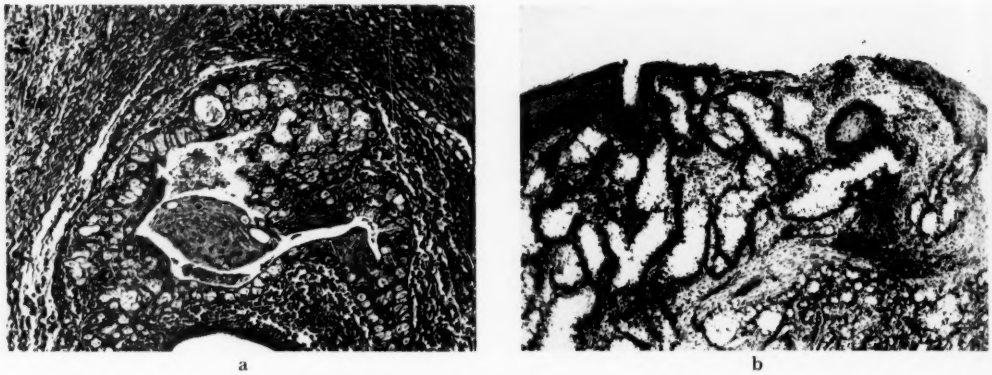

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FIG. 3. a, Mucoepidermoid tumor of the tongue illustrating the admixture of mucous and epidermoid components. This growth shows an inflammatory reaction also. Hematoxylin and eosin, ×86. b, Lingual mucoepidermoid with areas of ulceration. Hematoxylin and eosin, ×40.

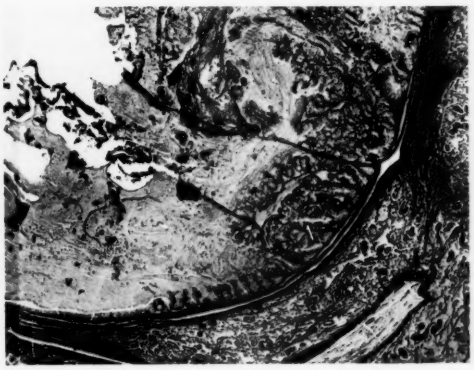
vestigated because the original pathologic report indicated a tumor of glandular origin. The preserved tissue and all available microscopic slides from these 60 cases were reviewed. When necessary, additional microscopic sections were prepared from the preserved specimen. For the most part, hematoxylin and eosin stains were used. Occasionally, variations in staining techniques required the use of other stains, such as the modification of Mayer's mucin stain. Several cases were eliminated from the study because they failed to provide histologic evidence of glandular origin. Additional cases were eliminated because of doubt regarding origin from the tongue. In one or two instances, original slides and tissues were not available. The present report deals with the clinical and pathologic details of the resulting group of 43 cases of glandular neoplasm of the tongue.

PATHOLOGIC DATA

Gross features. In only 11 cases was the material such as to suggest that total or subtotal removal of the tumor had been performed. Almost invariably the tumors were large, measuring up to 3 to 4 centimeters in diameter (Fig. 1a), and most of them occupied the base of the tongue where they were often found to be deeply invading the underlying musculature of the tongue (Fig. 1b). They were usually round or oval, with smooth mucosal surfaces (Fig. 1a); some were lobulated. The overlying mucosa in most cases was adherent, pale, and smooth, although occasionally ulcers were found over the dome of the bulging mass.

Microscopic features. The tumors were divided into four groups on the basis of their histologic appearance: (1) cylindroma, (2) mucoepidermoid, (3) adenocarcinoma, and (4) mixed tumor.

Cylindroma. There were 22 cases of cylindroma, 51 per cent of the total. The characteristic architecture of these tumors was that of small, dark-staining epithelial cells grouped to form honeycombed cylinders or plugs in a hyalinized connective tissue stroma (Fig. 2a). Many of the spaces within the honeycombed area were clear, while some were filled with a hyaline substance (Fig. 2b), and still others were occupied by a material that sometimes stained positively for mucus. The nuclei of the dark-staining cuboidal cells were hyperchromatic and the cytoplasm scanty. Mitotic figures were not frequently found. In some instances, the epithelial plugs were disposed in solid islands and strands, with no evidence of the Swiss cheese appearance. In a few instances, areas of the tumor exhibited irregular masses, strands, and islands of closely packed epithelial cells with practically no



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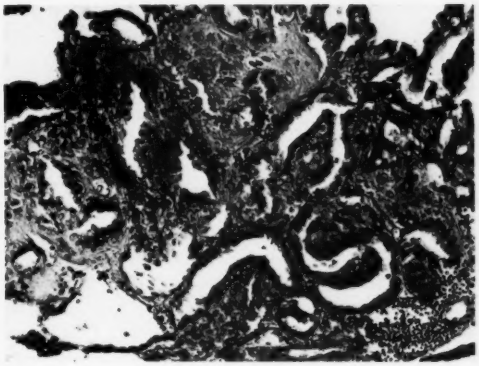

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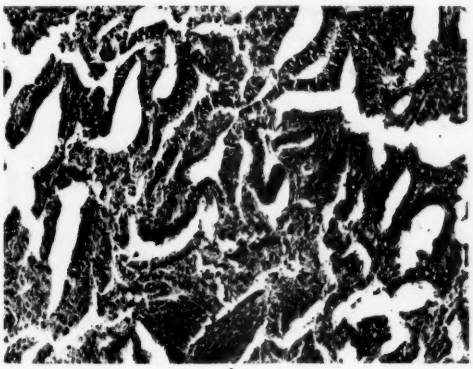

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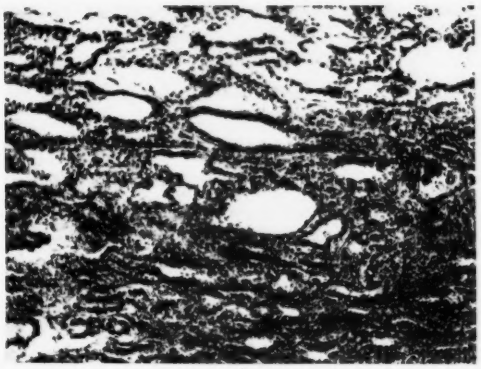

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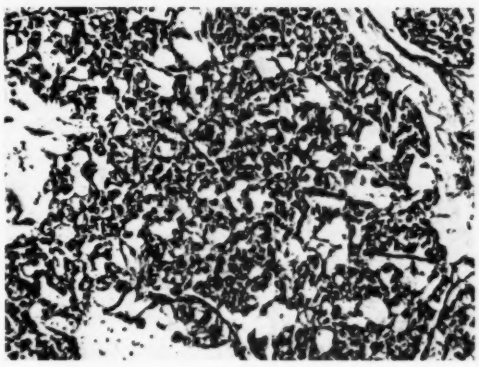

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FIG. 4. a, Grade 1 papillary mucous adenocarcinoma, ordinary type, showing multicentric origin from the lining of a ductlike structure. Many of these mucous tumors contained areas of calcification. Hematoxylin and eosin, ×22. b, Grade 2 mixed papillary and alveolar adenocarcinoma primary in the tongue. Hematoxylin and eosin, ×72. c, Papillary adenocarcinoma of the base of the tongue reminiscent of thyroid carcinoma. Hematoxylin and eosin, ×123. d, Thyroid-like follicular adenocarcinoma, grade 2, of the base of the tongue. Hematoxylin and eosin, ×86. e, Acinic cell carcinoma of the tongue, a rare neoplasm in this location. Hematoxylin and eosin, ×102.

intervening stroma. Other areas presented, between the epithelial cell masses, wide zones of connective tissue varying from hyaline to myxomatous.

One of the most constant findings, in those cases in which nerve tissue could be identified, was the tendency of the tumor to involve the perineural spaces (Fig. 2c). The overlying mucosa was generally not involved by ulceration; however, in many cases a pseudoepitheliomatous hyperplasia was found overlying the tumor (Fig. 2a).

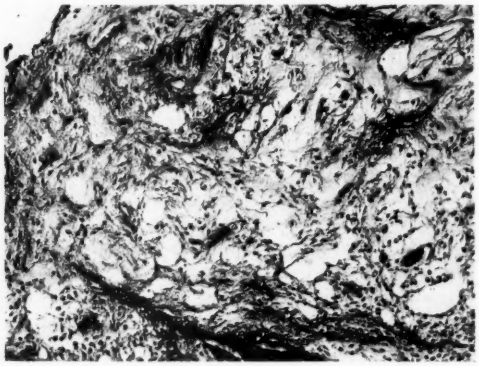


FIG. 5. Lingual mixed tumor. The epithelial component is scanty as a result of overgrowth in the myxomatous connective tissue matrix. Hematoxylin and eosin, ×72.

Mucoepidermoid. Eleven mucoepidermoid tumors were found, comprising 26 per cent of the total series. This group of glandular neoplasms presented varying histologic appearances. Most of these tumors, considered to be of ductal origin, were fairly well differentiated (Fig. 3a), with the epidermoid and mucus-producing elements in approximately equal proportions. The epidermoid cells were all similar in size, shape, and staining qualities. The cytoplasm was generally abundant and pale staining. Glandular elements consisted of mucus-producing cells. Escape of mucus into the surrounding tissue with resultant inflammatory reaction and fibrosis was observed in some cases. Muscle and lymphatic invasion was common, and calcification was a frequent finding. A tendency for these tumors to ulcerate through the overlying mucosa was evident in the majority of the cases (Fig. 3b). We achieved no success in our attempt to divide the tumors into malignant and benign categories on the basis of microscopic appearance and correlation with follow-up information.

Adenocarcinoma. Within this group of 9 cases, 21 per cent of the total, we found great variation in microscopic appearance (Fig. 4). The majority of these neoplasms presented a cellular picture of papillary adenocarcinoma. The epithelial cells making up the papillary adenocarcinomas were, as a rule, small, dark-staining cuboidal cells, with rather large centrally placed hyperchromatic nuclei (Fig. 4b). The cells, for the most part, were fairly well differentiated. That these tumors are of ductal origin seemed demonstrated by the occasional transition from the single cell layer of an epithelium lined duct to the papillary adenocarcinoma as shown in Figure 4a. Calcifications were found occasionally in these tumors. Invasion of muscle tissue was observed, as was the propensity for invasion of lymphatics. In some sections, a stromal pattern not unlike that seen in mixed tumors was found. Some of these adenocarcinomas were cystic. The production of mucus was frequently observed, both in the epithelium and in the surrounding connective tissue stroma (Fig. 4a).

The resemblance to thyroid adenocarcinomas seemed strong in 4 tumors, which were chiefly papillary or follicular in nature (Fig. 4c and d).

In one of the cases classified in the adenocarcinoma group, the tumor strongly resembled an acinic cell carcinoma (Fig. 4e). The epithelial cells predominated over the scanty stroma, and the cells were making an attempt at gland formation. We have observed material, in consultation, from still another acinic cell carcinoma of the tongue.

Mixed tumor. The extreme rarity of the occurrence of a true mixed tumor on the tongue is borne out in this study inasmuch as only 1 tumor satisfied the requirements we established for inclusion in this group. Characteristically, a true mixed tumor must contain epithelial elements arranged in solid masses, strands, or alveoli, and connective tissue elements varying from hyaline cartilage, immature fibrous connective tissue, or myxomatous stroma.

In this case, the tumor presented predominantly a myxomatous connective tissue stroma, with minimal evidence of epithelium (Fig. 5). The epithelial elements seemed to fuse almost imperceptibly with the supporting connective tissue cells. This

tumor was encapsulated, and its growth pushed aside the musculature of the tongue. Several of the cylindromas contained areas suggesting true mixed tumor. We have, however, classified these growths as cylindromas, since in a previous study "intermediate" neoplasms of this double composition behaved clinically according to the malignant pattern of the cylindroma.

CLINICAL DATA

Incidence. The incidence of tumors of a glandular nature was approximately 1 per 46,500 admissions. Since the 43 cases were obtained from a survey of more than 3,800 lingual neoplasms, both malignant and benign, glandular neoplasms occurring on the tongue constituted only about 1 per cent of all lingual neoplasms, a figure half that reported by Owen. Cylindromas constituted 51 per cent of our total series of 43 cases of glandular tumors, a figure considerably higher than the 10 per cent reported by Quattlebaum and associates in the parotid gland, the 15 per cent reported by Stein and Geschickter in the parotid gland, and the 18 per cent reported by Dockerty and Mayo (7) for the submaxillary gland. Mucoepidermoids comprised 26 per cent of our total group. There are no comparative figures for the frequency of occurrence of this tumor on the tongue. Nine of our cases, 21 per cent, were classified in the adenocarcinoma group, comparing favorably with Watson's figure of 17 per cent. The extreme rarity of true mixed tumors of the tongue is borne out in this study, with only 1 mixed tumor being found in the entire series.

Sex of patients. Twenty-two patients were men and 21 were women. This is in agreement with the literature which generally states that "mixed tumors" show no predilection for either sex. However, among the 22 cylindromas, more women (13) than men (9) were involved. In contrast to this, in the mucoepidermoid group there was a significant preponderance of men (8) over women (3). The adenocarcinoma group was almost equally divided, with 4 men and 5 women, while the single case of mixed tumor was in a man.

Age of patients. The over-all average age at the time of diagnosis was 52.9 years, with the youngest being 19 and the oldest being 77 years. The ages of the 22 patients with cylindroma ranged from 37 to 72 years, with an average of 54.4 years. Stein and Geschickter found that cylindromas occur mostly among middle-aged persons. The 11 patients with mucoepidermoid tumors ranged in age from 26 to 77 years, the average being 56.5 years. The ages of the 9 patients in the adenocarcinoma group ranged from 19 to 71 years, the average being 47 years. The 1 mixed tumor occurred in a 33 year old man.

Symptoms. One of the most constant symptoms was "pain," this complaint having been made by 35 of the 43 patients. Twenty-one of the 22 patients with cylindroma complained of pain. In the mucoepidermoid group, 3 of the 11 patients had no symptoms whatsoever, the tumor being discovered during routine examination. In the adenocarcinoma group, 8 of 9 patients had pain, 1 patient having had no symptoms of any kind. The 1 patient with mixed tumor was asymptomatic.

Swelling was listed in 22 of the 43 histories, sore throat and dysphagia in 15, and earache in 4; and several miscellaneous complaints such as burning tongue, metallic or otherwise altered taste, tickling in the throat, and bleeding were noted.

The duration of the symptoms averaged about 2 years (range 11 weeks to 7 years) in patients with cylindroma, nearly a year (range 5 days to 3 years) in those with mucoepidermoid, and only 3 to 4 months in those with adenocarcinoma.

On clinical examination, 32 tumors were unilateral, 17 involving the right side of the tongue and 15 the left. Ten involved the entire base and were considered to be bilateral, while 1 was spread over the entire tip of the tongue. All except 4 of the tumors were located at the base of the tongue.

Most of the tumors were large, averaging 3 to 4 centimeters in diameter (Fig. 1). The majority were clinically firm and apparently fixed to the underlying musculature. The overlying mucosa in most instances was intact; however, in some instances minor degrees of ulceration were observed.

Fourteen of the 43 patients had received prior treatment which had been followed by recurrence of the tumor. Of these 14 recurrent tumors, 9 were cylindromas, 3 were mucoepidermoids, and 2 were adenocarcinomas. The prior treatments included irradiation, excision, local applications, and, in some instances, only biopsy.

TREATMENT AND RESULTS

Twenty-nine of the 43 patients were treated solely by roentgen irradiation. Eleven patients had excision of their lesions and 5 of these had concomitant dissection of the neck. Three patients whose lesions were considered incurable received no treatment other than biopsy. Twenty-nine of the patients received their primary treatment at the Mayo Clinic. The other 14 had received prior treatment elsewhere and the lesions had recurred.

At the time of this report, 21 of the patients were alive and 22 were dead. Nine of those who had suffered from cylindroma were living 14 months to 13 years after operation, while the other 13 had died 2 days to 9 years after treatment. Seven of those with mucoepidermoid were alive 2 to 25 years after operation, while the other 4 had died 1 to 24 years after operation. The adenocarcinoma group included 5 who died 7 months to 7 years after treatment and 4 who lived 3 to 16 years after treatment. The 1 patient with mixed tumor was still alive 4 years after excision.

Ten recurrences followed primary treatment at the Mayo Clinic. Three tumors were adenocarcinomas, 1 was a mucoepidermoid, and 6 were cylindromas. Distant metastasis occurred in 5 cases: in 3 cases, cylindromas metastasized to the liver, upper cervical chain, and submaxillary nodes, respectively; in 1 case a mucoepidermoid metastasized to a deep jugular node; and in 1 an adenocarcinoma metastasized to the carotid chain of lymph nodes. The cylindroma that metastasized to the liver is the one previously reported by Mayo and one of us (M.B.D.) (8). Necropsy data on the deceased patients were not available for this study. It has been assumed that most of these patients died of their disease, although several of the follow-up letters pertaining to patients who died in the sixth and seventh decades of life imply that death was perhaps due, in fact, to unrelated causes.

COMMENT

Tumors of a glandular nature occurring on the tongue have, for many years, been lumped together in the category of mixed tumors. Although cylindromas, mucoepidermoids, adenocarcinomas, and true mixed tumors all occur in similar locations on the tongue and, undoubtedly, arise from the same mucous and salivary glandular structures, there is no justification for continuing to include all of these tumors in the category of mixed tumors.

In the present study, we classified these glandular neoplasms on the basis of their histopathologic characteristics. Such a grouping we found useful not only from the standpoint of clinical behavior but also with regard to treatment and prognosis. These tumors can be listed in the order of their clinical seriousness as follows: (1) cylindroma, (2) adenocarcinoma, (3) mucoepidermoid, and (4) mixed tumor. All of these tumors with the exception of the mixed tumor must be considered malignant, since they have proved to be capable of distant metastasis.

The clinical symptoms such as pain, swelling, and bleeding were by no means differentially diagnostic. The clinical incidence of pain was 81 per cent in the total series, and it may be significant that the incidence was 95 per cent in the cylindroma group. The duration of symptoms (average 2 years) in the cylindroma group was longer than that

in either the mucoepidermoid or the adenocarcinoma group, both of which accounted for about a year of clinical difficulty. Bleeding appeared to be much more frequently associated with mucoepidermoid and adenocarcinoma than with cylindroma, wherein it was reported in 1 case only. The mucoepidermoids characteristically occurred in the older age group of predominantly male patients.

Since total or subtotal removal was attempted in only a few instances, any statistical data regarding treatment and results from a surgical aspect would not be valid. However, we are impressed by the observation that 10 of 11 patients subjected to wide excision of the lesion with or without hemimandibulectomy, glossectomy, and dissection of the neck are still living. There was 1 hospital death in this group.

Many of the tumors were found to be infiltrative in nature, and the sometimes benign clinical appearance of the lesion was of little help to the surgeon in attempting to make a differential diagnosis. Particularly notorious for this type of behavior was the cylindroma, which tended to involve the perineural spaces, often at some distance from the clinically observable mass.

It is our impression, therefore, that the surgeon should not be deceived by the apparent encapsulation of some of these tumors. When possible, radical surgical excision should be employed. In certain instances in the treatment of some of the more extensive adenocarcinomas, irradiation may be the only logical treatment. For the extremely rare, true mixed tumors that occasionally may be found on the tongue, complete enucleation of the mass with its capsule intact is considered to be adequate treatment.

SUMMARY AND CONCLUSIONS

Forty-three glandular tumors of the tongue, many of which had previously been diagnosed as mixed tumor, were classified into four groups on the basis of their histologic pattern. Cylindromas accounted for 51 per cent of the series. They were characterized clinically by pain; however, the duration of this symptom was relatively long (2 years) before these patients sought treatment. Local fixation of the tumor to the underlying musculature of the tongue was a feature, as was the surgical observation that these tumors were infiltrative. Pathologically, the infiltrative tendency was marked, as was the predilection to extend to the perineural spaces. This group of neoplasms presented the most unfavorable prognosis.

Mucoepidermoids, heretofore only rarely described as appearing on the tongue, constituted almost 26 per cent of the series. This group was the most favorable one encountered from the standpoint of prognosis, excepting the mixed tumor group. Surface ulceration of the overlying mucosa tended to occur.

Adenocarcinomas constituted 21 per cent of the series; some were papillary, some resembled thyroid adenocarcinomas, and 1 was classified as an acinic cell neoplasm. Prognosis was dependent on the extent of dedifferentiation and also on the extent of local invasion. These tumors tended not to be encapsulated and often gave rise to metastasis. The best therapeutic results were obtained by wide excision of the tumor.

The extreme rarity of true mixed tumor of the tongue is borne out by the fact that only 1 was found in this series. It appeared to be inherently benign and contained very little epithelial constituent.

Excellent results followed radical surgical operations, whereas disappointing results followed the earlier policy of irradiation, particularly in the cylindroma group. It seems that, whenever possible, more radical surgical procedures should be employed in the hope that better results in the treatment of these neoplasms may be achieved.

REFERENCES

1. BAUER, W. H., and FOX, R. A. Adenomyoepithelioma (cylindroma) of palatal mucous glands. Arch. Path., Chic., 1945, 39: 96–102.
2. BELL, E. T. A Text Book of Pathology. 8th ed., p. 420. Philadelphia: Lea & Febiger, 1956.

3. Billroth, T. Quoted by Kramer, Rudolph, and Som, M. L.: Cylindroma of the upper air passages; a cylindromatous type of mixed tumor. Arch. Otolar., Chic., 1939, 29: 356–370.
4. Brunschwig, Alexander. Mixed tumors of the tongue and sublingual gland. Surg. Gyn. Obst., 1930, 50: 407–415.
5. Buxton, R. W., Maxwell, J. H., and French, A. J. Surgical treatment of epithelial tumors of the parotid gland. Surg. Gyn. Obst., 1953, 97: 401–416.
6. Cheyne, V. P., Tiecke, R. W., and Horne, Eleanor V. A review of so-called mixed tumors of the salivary glands including an analysis of fifty additional cases. Oral Surg., 1948, 1: 359–402.
7. Dockerty, M. B., and Mayo, C. W. Primary tumors of the submaxillary gland with special reference to mixed tumors. Surg. Gyn. Obst., 1942, 74: 1033–1045.
8. Idem. "Cylindroma" (adenocarcinoma, cylindroma type). Surgery, 1943, 13: 416–422.
9. Foote, F. W., Jr., and Frazell, E. L. Tumors of the major salivary glands. Cancer, 1953, 6: 1065–1133.
10. King, W. L. M., and Pemberton, J. deJ. So called lateral aberrant thyroid tumors. Surg. Gyn. Obst., 1942, 74: 991–1001.
11. Krompecher. Quoted by Brunschwig, Alexander (4).
12. Lampe, I. Pseudo-adenomatous basal-cell carcinoma of the tongue (salivary gland tumor). Radiology, 1942, 39: 54–61.
13. LeMaitre, Yves. Quoted by McDonald, J. R., and Havens, F. Z. (14).
14. McDonald, J. R., and Havens, F. Z. A study of malignant tumors of glandular nature found in the nose, throat, and mouth. Tr. Am. Laryng. Ass., 1946, 50: 449–470.
15. McDonald, J. R., Moersch, H. J., and Tinney, W. S. Cylindroma of the bronchus; report of 6 cases. J. Thorac. Surg., 1945, 14: 445–453.
16. McFarland, Joseph. Ninety tumors of the parotid region; in all of which the postoperative history was traced. Am. J. M. Sc., 1926, 172: 804–848.
17. Idem. Tumors of the parotid region; studies of one hundred and thirty-five cases. Surg. Gyn. Obst., 1933, 57: 104–114.
18. Mulligan, R. M. Metastasis of mixed tumors of the salivary glands. Arch. Path., Chic., 1943, 35: 357–365.
19. Owen, May. Lesions of the tongue, with special reference to their location. Texas J. M., 1927, 22: 693–696.
20. Quattlebaum, F. W., Dockerty, M. B., and Mayo, C. W. Adenocarcinoma, cylindroma type, of the parotid gland; a clinical and pathologic study of twenty-one cases. Surg. Gyn. Obst., 1946, 82: 342–347.
21. Stein, Irvin, and Geschickter, C. F. Tumors of the parotid gland. Arch. Surg., Chic., 1934, 28: 492–526.
22. Stewart, F. W., Foote, F. W., and Becker, W. F. Mucoepidermoid tumors of salivary glands. Ann. Surg., 1945, 122: 820–844.
23. Volkmann, R. Quoted by Brunschwig, Alexander (4).
24. Watson, W. L. Adenocarcinoma of the oral cavity. Am. J. Roentg., 1935, 34: 53–62.
25. Woolner, L. B., Pettet, J. R., and Kirklin, J. W. Mucoepidermoid tumors of major salivary glands Am. J. Clin. Path., 1954, 24: 1350–1362.

THE EVALUATION OF THE INTERNAL ANAL SPHINCTEROTOMY OPERATION WITH SPECIAL REFERENCE TO ANAL FISSURE

STEPHEN EISENHAMMER, M.B.(Ed.), F.R.C.S.(Eng.), Johannesburg, South Africa

THE OPERATION of internal anal sphincterotomy was introduced in 1951 (2) primarily for the cure of anal fissure. It is now opportune for an evaluation of this procedure as, with the passage of time and the resulting accumulated experience, it has been found that more judgment and caution should be exercised in the performance of this relatively simple operation.

MUSCULATURE OF THE ANAL CANAL

The internal anal sphincter is the thickened terminal portion of the circular coat of the rectum. It is unstriated and forms the inner involuntary muscle layer of the treble muscle coat of the anal canal. It begins, superiorly, at the anal inlet where the rectum passes through the pelvic diaphragm and terminates at the outlet or anal verge where its prominent free rounded border is distinctly palpable and often visible. Here, it is separated by the anal intermuscular groove from the subcutaneous portion of the external sphincter which lies below and lateral to it. The dentate line is situated at about the level of the midpoint of the internal sphincter. The internal sphincter varies from 25 to 35 millimeters in length and from 4 to 7 millimeters in width. When dividing the muscle on the stretch it varies from about 2 to 4 millimeters.

The middle layer of the anal canal muscular wall consists of the conjoined longitudinal muscle, which is formed of the fibromuscular extensions from the levator ani muscle—the puboanal muscle of Uhlenhuth and its fascia—which fuse with the longitudinal muscular coat of the rectum. This conjoined sheath contains both smooth and striated muscle fibers and connects the puborectalis and pubococcygeus muscles to the rectal wall. As the muscle proceeds distally it becomes largely fibroelastic, and at the lower border of the internal sphincter, in the intermuscular groove, it breaks up into two main layers which pass superiorly and inferiorly beneath the anoderm and skin. The upward terminal fibroelastic smooth muscle fibers encircle the lower margin of the internal sphincter and are attached to the connective tissue of the pecten zone forming a dense matrix which is closely related to the anoderm. Fine and Lawes named these smooth muscle fibers the musculus submucosa ani, whereas the older anatomists called it the muscularis mucosae. Parks stressed the condensation and fixation of these fibers at the anal valve line and named it the mucosal suspensory ligament. The inferior main layer continues round the medial aspect of the subcutaneous portion of the external sphincter and these terminal fibroelastic smooth muscle fibers fan out and insert into the perianal skin forming the inner fibers of the corrugator cutis ani muscle which puckers the skin of the anus. In addition, the conjoined longitudinal muscle gives off fibromuscular extensions which pass through the outer portion of the external sphincter and insert into the perianal skin forming the outer fibers of the corrugator cutis. The conjoined longitudinal muscle fuses the musculature of the anal canal into one composite unit.

The outer muscle layer of the anal canal is formed by the striated voluntary external sphincter. The subcutaneous portion divaricates to become V-shaped posteriorly and

inserts into the anococcygeal body and coccyx, and anteriorly the fibers insert into the central tendinous raphe. At its uppermost end, the external sphincter fibers intermingle posteriorly with the puborectalis portion of the levator ani muscle. Anteriorly, its muscle fibers decussate and join with the transverse perineal muscles, and also merge with extensions from the pubococcygeus muscle, which fuse in front of the rectum. The subcutaneous portion of the muscle is traversed by terminal septa from the conjoined longitudinal muscle.

The anorectal muscle ring is the important musculofascial collar which completely surrounds the anorectal junction. It is made up of the puborectalis muscle combined with the deep portion of the external sphincter and the fibroelastic extensions from the levator fascia and the levator ani muscle to the longitudinal musculature of the rectum. Only posteriorly is the anorectal ring prominent and here it forms the levator shelf.

ANAL CANAL FUNCTION

The anal canal is closed at rest by the continuous postural tone of both the voluntary and involuntary muscle components of the anal canal. Continence of the anal canal is ably discussed in 2 articles by Fansler (6, 7). He states that the chief use of the internal sphincter is to empty the canal completely after the passage of each fecal mass. He also states that continence depends primarily upon the anatomic construction of the rectum and the anterior location and angulation of the anal canal in relation to the rectum rather than to tonic contraction of the sphincteric musculature.

The internal orifice or commencement of the anal canal is set obliquely to the face of the anterior wall of the rectum. Posteriorly, above and behind the levator shelf, is situated the rectal pouch which acts as a reservoir. This pouch lies in the long axis of the rectum and consequently in the optimum direction of force acting from above. When voluntary closure is effected, the involuntary internal sphincter also contracts because of contiguous stimuli. The internal orifice is closed and simultaneously drawn up against the anterior rectal wall by the action of the puborectalis and anorectal muscle ring. This action is accompanied by a slight backward angulation of the long axis of the canal. The posterior rectal pouch effect is thus accentuated, and any acute force from above is diverted from the entrance of the canal to the pouch.

When a voluntary expulsive force is exerted, the puborectalis, the anorectal muscle ring, and the muscles of the anal wall all relax. The anterior angulation is lost as a result of the canal entrance moving backward. The posterior rectal pouch disappears and the long axis of the anal canal is now continuous with that of the rectum. In the act of forceful evacuation, to the examining finger the canal appears to fold like a concertina downward and also to become funnel-like.

The function of the internal sphincter may thus be summarized as follows:

1. It contributes a full part in maintaining continuous postural closure of the anal canal in the resting state. This voluntary postural tonus is increased by any extra stimulus caused by excessive flatus pressure or fluid irritating feces occurring in the rectal ampulla.

2. In voluntary closure of the canal, it supplements the voluntary muscles by increased contraction consequent upon contiguous stimuli.

3. It absolutely controls the degree of anal canal dilatation by virtue of it being involuntary and forming the innermost coat of the sphincter muscle.

4. It empties the anal canal by its detrusor action and nips off the fecal mass at the outlet which corresponds to the lower free rounded border of the internal sphincter. This latter action may be likened to a retroperistaltic wave.

Generally, nature has endowed the anal musculature with an excess of tone and strength, allowing man a margin of safety.

Nevertheless, there is a wide variation in the strength and the tone of the anorectal musculature. In some individuals it is with great difficulty that instrumentation is performed, and on commencing withdrawal the instrument is literally forced out. At the other extreme, the muscles are weak and atonic and offer little or almost no resistance to instrumental examination and on withdrawal of the instrument the canal at first gapes and then closes down slowly. Yet, here too, normal continence exists. A tightly postured internal sphincter is a disadvantage and predisposes to anal pathologic change.

SURGICAL APPLICATION

Total division of the internal sphincter, whether midposterior, posterolateral or midlateral, in an individual with powerful anorectal musculature leaves no noticeable functional defect although there is a diminution in postural tone, voluntary closure, and total emptying of the anal canal.

When postural tone and voluntary muscle strength are moderate, complete division causes slight but definite interference. Occasional noisy escape of flatus may occur. Complete emptying of the terminal part of the anal canal is defective and causes some discharge or soiling unless special post-defecation cleansing methods are used. Loose motions now spatter the posterior surface of the toilet pan.

If tone and strength of the anal canal are poor, total division of the internal sphincter leads to partial incontinence both of gas and feces. This applies particularly to the aged patient.

TYPE OF MUSCLE DIVISION

When choice permits, the lateral and posterolateral type of muscle division is still preferred, for it appears that functional disturbance is less noticeable following this procedure than when midposterior division is performed. Anterior division weakens the sphincter most and is, therefore, reserved for the anterior intermuscular fistulous abscess. Lateral wounds heal more readily than those of the posterior midline.

Linear division of the internal sphincter to the dentate line (Fig. 1), which represents the midpoint of the muscle, is the standard procedure for the cure of the anal fissure and for the moderate degrees of contracture or stenosis. This amount of division generally suffices for the cure of the low intermuscular fistulous abscess. When muscular relaxation is the object of the operation and the tone and muscle strength are very high, and the patient is extremely nervous and apprehensive, then a three-quarter division may be considered preferable to the usual half division. Again, if a standard half division of the internal sphincter to the dentate line is done and more relaxation is desired, yet caution suggests fear of incontinence, then a partial division in width of the upper segment may be carried out submucosally.

If after 14 days, the division is deemed insufficient, a further division under local anesthesia as an ambulatory procedure may be carried out. The division may be extended through the original incision or a new secondary one undertaken. Total sphincterotomy is necessary for the cure of the high intermuscular fistulous abscess and for the severe degrees of anal stenosis.

INDICATIONS FOR THE OPERATION OF INTERNAL ANAL SPHINCTEROTOMY

Anal fissure. The commonest use of this operation is for the cure of anal fissure. It was based on the principle that the fissure is maintained by the chronic spasm and contracture of the internal sphincter.

As a rule, an anal fissure occurs in the external part of the anal canal over the lower portion of the internal sphincter, the greatest incidence being in the posterior midline or to its right. The explanation rests with a number of factors. Firstly, the posterior midline at the exit or lower portion of the anal canal over the internal sphincter is the most unsupported point of the anal skin because of the bifurcation or V-shaped

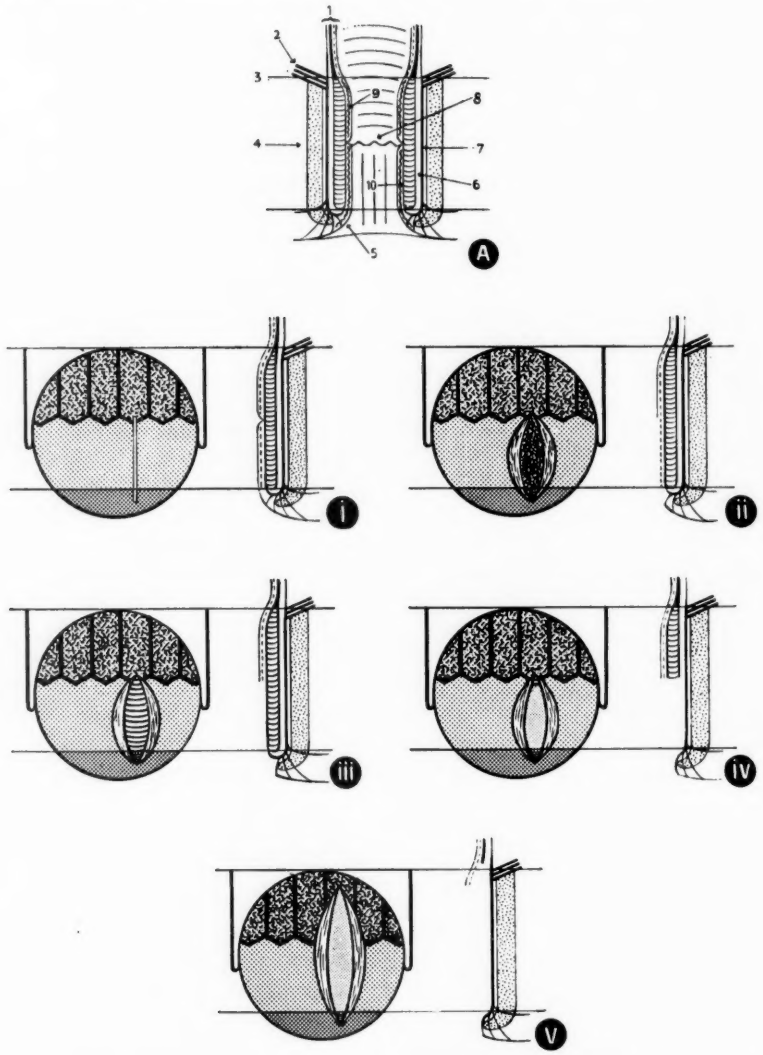


FIG. 1. A, coronal section of anal canal. *1*, Rectal wall; *2*, puborectalis muscle; *3*, anorectal line; *4*, external sphincter; *5*, anal intermuscular sulcus; *6*, anorectal intermuscular space; *7*, conjoined longitudinal muscle; *8*, dentate line; *9*, superior hemorrhoidal plexus above dentate line, below, inferior plexus; *10*, internal sphincter. i–iv, Standard procedure of internal anal sphincterotomy operation to dentate line. Diagrammatic representation of direct view with adjacent longitudinal sectional view. i, Anal canal exposure with Sims' speculum showing incision from dentate line to anal verge. ii, Anoderm divided, subepithelial tissue exposed. iii, Completed division of subepithelial layer exposing pearly white internal sphincter in whole length of wound except at lower angle where fleshy pink subcutaneous portion of external sphincter is shown, being separated from internal sphincter by main terminal layers of conjoined longitudinal muscle. iv, Internal sphincter divided in whole length of wound, floor now formed by fascia-like fibromuscular conjoined longitudinal layer. Upper angle shows cut edge of internal sphincter; external sphincter occupies lower angle. v, Total internal anal sphincterotomy operation; complete muscle division extended into circular muscle of rectum; uppermost division done submucosally.

divergence of the subcutaneous part of the external sphincter. In the remainder of the canal outlet, the external sphincter hugs the lower border of the internal sphincter. This posterior angle is thus subjected to the greatest degree of stretch when an abnormal force occurs from above and becomes the bursting point of the anal canal skin.

The second, and probably the most important factor, is that the modified skin or anoderm of the anal canal is exceptional because it is tethered by fibroelastic muscular extensions, the terminations of the conjoined longitudinal muscle. Those inserting into the perianal skin form the corrugator cutis ani muscle which causes the longitudinal puckering. When active this muscle pulls the posterior midline skin bilaterally at the anal outlet. The anoderm of the lower part of the anal canal, the pecten zone, has the inner terminations of the fibroelastic muscular extensions inserted into it. These represent the muscularis mucosae and are seen as the longitudinal fibers in the floor of an acute fissure. The modified skin, or anoderm, of the lower anal canal is normally elastic and freely mobile but when acute or chronic irritation exists these fibers become overactive and immobilize and fix the skin, rendering it inelastic and friable. The same factors cause the corrugator fibers to exert an abnormal bilateral drag on the midline skin of the anal outlet. These terminal fibroelastic muscular extensions of the conjoined longitudinal muscle usually function in close association with the internal sphincter with which they are connected, but more important is that they may be overactive in an atonic anal canal.

Thirdly, the anoderm of the outer part of the anal canal in the posterior quadrant is often undermined above by deep crypts. This in itself weakens the skin distal to the crypt sufficiently to allow a tear to occur when abnormal force impinges upon it.

Fourthly, there is the "traction" factor. This is the drag of a prolapsing hemorrhoid or polyp that occurs most commonly in the right posterior area. An acute hematoma in the posterior quadrant and less often in the anterior quadrant also may cause an acute traction tear.

Anal fissure may be classified as follows: (1) acute, primary, or secondary and (2) chronic, primary, or secondary. The acute primary fissure is a tear occurring at the classical posterior midline site in a normal anal canal. It is caused by an undue expulsive force from a large scybalous fecal mass. The other frequent cause is acute diarrhea, the irritation of which sets up acute internal sphincter spasm plus the overaction of the corrugator cutis and muscularis mucosae fibers. The skin lining of the anal canal at the weak site is thus very liable to tear. The acute secondary fissure supervenes on pre-existing pathologic states. The most common of these is that of traction caused by the drag of a prolapsing hemorrhoid or fibrous polyp, situated usually in the right posterior quadrant and less often anteriorly. Similarly, acute hematomas situated posteriorly or anteriorly may cause an acute fissure. Lateral traction seldom causes a tear. Acute constipation or diarrhea also precipitates the acute secondary fissure. A large crypt may be the cause of a secondary acute fissure in the posterior quadrant. More often it is an additional factor in the causation of an acute primary fissure. The floor of the acute fissure shows the brick-red longitudinal fibers of the muscularis mucosae.

If the factors maintaining the acute fissure are not removed, then the chronic syndrome supervenes. The tear deepens and becomes complete, the base now being formed by the pale transverse fibers of the internal sphincter. At the outer extremity of the fissure, there develops a chronic fibroedematous tag known as the sentinel pile, while at the upper end of the classical primary central fissure a fibrous papillary polyp makes its appearance. The secondary type of chronic fissure rarely forms an internal polyp except in the midanterior fissure. It is in the secondary chronic fissure that the internal sphincter may show little or

no chronic spasm or contracture, especially in the elderly.

TREATMENT

It is thus seen that multiple factors operate both in the cause and maintenance of an anal fissure, and thus a more advanced approach to its cure is suggested.

The acute primary fissure is treated by conservative therapy of local analgesic ointments, judicious use of a dilator, correction of the bowels, and codeine compounds for the control of pain. If the patient is extremely emotional and hypersensitive, a partial internal sphincterotomy to the dentate line is the best emergency procedure. Only extremely rarely may an infiltration of 5 cubic centimeters of a long acting oily anesthetic solution into the posterior quadrant of the lower anorectal intermuscular space be permitted under stringent aseptic technique and coverage with a massive dose of long acting penicillin.

The acute secondary or traction type of fissure is corrected by removal of the cause, as a dissection-enucleation of an acute hematoma, ligation and excision of a prolapsing polyp, or a sclerosing injection to correct the drag of a prolapsing internal hemorrhoid. This procedure is combined with the conservative therapy recommended for use in cases of acute primary fissure.

When the fissure has become established or chronic, then operative treatment alone is curative. The principle was postulated (2, 3) that the chronic fissure is maintained by the chronic spasm or contracture of the internal sphincter and that a simple cure is effected by the operation of internal sphincterotomy. A four-fifths muscle division was recommended for the standard operation, and, in pronounced contractures, a total division extending to the circular muscle of the rectum. Brossy has stated that he recommends a far more complete sphincterotomy than that of previous authors, viz., a total sphincterotomy, and he stressed the importance of destroying the superior ridge resulting from a less complete section. This appears to be an individualistic viewpoint.

The chronic primary fissure is cured by the standard internal sphincterotomy to the dentate line which corresponds to a linear division of half the muscle. The pain of the fissure is parallel to the degree of spasm or contracture of the internal sphincter. When the muscles are powerful and pain and spasm are pronounced, a total division is sometimes indicated. Further relaxation beyond the standard half sphincterotomy may be obtained by diminishing the width of the remaining upper segment or performing a secondary sphincterotomy under local anesthesia later. The fissure is dealt with by removal of the internal hypertrophied papillary polyp above and the external tag (sentinel pile) below. All crypts are fully opened and the edges of the fissure undermined with scissors or scalpel to divide the tethering fibers. When the midline posterior fissure is situated in a deep groove surmounted on each side by a large congestive external hemorrhoidal mass, healing is facilitated by the excision of the varicose plexus through a longitudinal incision over the center of each mass. As the external plexus honeycombs the terminal fibroelastic muscular fibers that tether the skin, this dissection also mobilizes the skin.

In dealing with the posterior midline fissure, the author prefers a left lateral or posterolateral sphincterotomy. The question is asked as to why the muscle division is not performed through the fissure bed thus obviating a dual wound. The reason for this preference has been discussed previously; moreover, the fissure itself is interfered with so little that the sphincterotomy is the only true wound whether it be posteromidline or lateral.

The chronic traction causing a secondary fissure is dealt with by removing the prolapsed or prolapsing hemorrhoid or fibrous polyp that initiated it. This should be executed in a conservative manner. Unless sphincter spasm is pronounced, which is unusual, a minimal sphincterotomy through

the external portion of the wound is undertaken.

Not uncommonly, chronic fissures, mostly of the secondary type, are found in association with normal sphincter tone and even with relaxed or subnormal sphincteric muscle strength. Here it is imperative, especially in the elderly, to avoid division of the internal sphincter. Correction of the local causative factors effects a cure.

The operation for fissure is essentially an ambulatory procedure. The average healing time is 3 weeks, and it is helped if an antiseptic ointment, consisting of 5 milligrams of neomycin and 500 units of bacitracin per gram, is inserted morning and evening for the first fortnight.

The internal anorectal fistulous abscess. The next most frequent use of this operation is for the cure of the internal fistulous abscess, as described previously (4, 5). The acute high intermuscular fistulous abscess requires a total division of the internal sphincter extending into the circular muscle of the rectum. Ten per cent of the acute anorectal fistulous abscesses are of this type which mostly occurs posteriorly. The less common anterior abscess, requiring total anterior division of the muscle, leaves some functional weakness. Over 80 per cent of all anorectal fistulous abscesses are of the low intermuscular variety originating from cryptoglandular units situated in the vicinity of the dentate line. The cure of this lesion, whether in the acute abscess or chronic fistulous stage, requires division of the internal sphincter to the dentate area where lie both the origin and the uppermost limit of this condition.

Anal stenosis or stricture. Congenital.—The simplest form of imperforate anus is caused by defects in the anal canal only. Congenital stricture of the anal canal occurs most often at the point of fusion of the proctodeum and hindgut. The stricture may assume any form from a mere slight fibrous ring at the anorectal line to a complete atresia, or there may be just a narrowness or smallness of the anus or a covering of some portion of the anal opening which is composed of cutaneous tissue.

For the cure of these lesions, incision of the fibrous tissue or septum alone is usually insufficient, and a partial division of the internal sphincter, to restore a good lumen, is required.

Internal sphincter stenosis or contracture.—This condition generally results from prolonged overpurgation and may reach such an extreme degree that the lumen is the size of a thermometer case. When occurring in the aged, it is also referred to as senile stenosis. In the severe types, a total muscle division is required to restore an adequate canal. In the lesser degrees, when postural tone and muscular strength are poor, especially in the feeble, a hasty decision should be avoided and the minimum done to restore a workable lumen.

There is a rare spasmodic stenosis due to sympathetic overactivity. This occurs in the younger age group. A total high division is necessary here as the whole muscle is hypertrophied and overactive.

Postoperative stenosis.—The commonest cause of postoperative stenosis is overextensive sacrifice of the mucocutaneous lining of the anal canal in the ligation and excision operation for the cure of hemorrhoids. In the lesser degrees of stenosis a partial sphincterotomy suffices to correct this condition. When a more advanced stenosis exists, a total sphincterotomy is necessary.

In cases in which the loss of the epithelium of the anal canal is very extensive, a total posterior midline sphincterotomy is executed, including division of the subcutaneous portion of the external sphincter. The mucosa above is mobilized freely and stitched to the anal wall below the dentate line. The remainder of the wound is covered with a thick free split skin graft. The anal canal possesses a special affinity for split skin grafts as has been stressed repeatedly by Hughes.

The hemorrhoid operation. The author has recommended a partial internal sphincterotomy in the ligation and excision oper-

ation for hemorrhoids (2, 3) to eliminate postoperative internal sphincter spasm and thus reduce pain, allow of easy stool, diminish the tendency to hemorrhage, and prevent stenosis. The muscle division is generally done in the left lateral or right posterior wound. When conservative procedures of a closed type are employed, the indication for a concomitant sphincterotomy grows much less.

Low lying benign intrarectal tumors. Division of the internal sphincter will greatly facilitate access per anum to extirpate an intrarectal tumor such as a villous papilloma or large adenoma.

Fecal impaction. This condition is often associated with a chronic contracture of the internal sphincter. Acute spasm is always present from the trauma inflicted by excessive straining. Disimpaction is essentially an office surgery or home procedure. The anal canal is anesthetized by local infiltration. If, by reason of its contracture, the internal sphincter requires division, this is undertaken. Next, the ampullary fecal mass is digitally fragmented and then a mixture of 4 ounces of pure warmed glycerine together with 4 ounces of warmed olive oil are injected quickly through a catheter, high into the pelvic colon, under pressure with a large rubber syringe. The patient is immediately transferred to a commode when spontaneous evacuation takes place. This is a clean and most effective method of treatment.

Internal sphincter constipation. There is a rare type of constipation due to neuromuscular inco-ordination of the internal sphincter resulting in a paradoxic muscular action. This condition responds to a muscle division. It may occur in young children. The more usual form is due to chronic contracture of the internal sphincter. The patient is aware of the fact that difficulty in passing the motion lies in the anal canal and often resorts to digital help to commence the action. Internal sphincterotomy corrects this disability.

CONCLUSION

The surgery of the anal canal is entering a new phase of conservatism. This applies especially to anal fissure, fistulous abscess, anal stenosis, and hemorrhoidal disability. The key to the surgical correction of these conditions lies in the complete understanding of the anatomy and function of the internal sphincter. Internal anal sphincterotomy has now become one of the most frequently performed surgical operations.

REFERENCES

1. Brossy, J. J. Anatomy and surgery of anal fissure; with special reference to internal sphincterotomy. Ann. Surg., 1956, 144: 991.
2. Eisenhammer, S. The surgical correction of chronic internal anal (sphincteric) contracture. South Afr. M. J., 1951, 25: 486.
3. Idem. The internal anal sphincter; its surgical importance. South Afr. M. J., 1953, 27: 266.
4. Idem. The internal anal sphincter and the anorectal abscess. Surg. Gyn. Obst., 1956, 103: 501.
5. Idem. A new approach to the anorectal fistulous abscess based on the high intermuscular lesion. Surg. Gyn. Obst., 1958, 106: 595.
6. Fansler, W. A. The repair of anorectal incontinence following operation for fistula. South. M. J., 1952, 45: 229.
7. Idem. Treatment of incontinence and other abnormalities following infection of the anal and rectal regions. Am. J. Surg., 1954, 88: 821.
8. Fine, J., and Lawes, C. H. W. On muscle-fibres of anal submucosa; with special reference to pecten band. Brit. J. Surg., 1940, 27: 723.
9. Hughes, E. S. R. Surgery of the Anus, Anal Canal, and Rectum. Edinburgh and London: E. and S. Livingstone, 1957.
10. Parks, A. G. The surgical treatment of haemorrhoids. Brit. J. Surg., 1956, 43: 337.

A 26 YEAR EXPERIENCE IN THE SURGICAL TREATMENT OF 5,037 PATIENTS WITH NONMALIGNANT BILIARY TRACT DISEASE

FRANK GLENN, M.D., F.A.C.S., New York, New York

SINCE 1932, a very careful account has been kept of those patients[1] with biliary tract disease who have been cared for in the surgical pavilions of The New York Hospital-Cornell Medical Center. During this period, detailed records have been maintained and frequently reviewed. Concomitantly, numerous studies upon selected groups of patients have been made, and several of these have been published. By 1958, a 26 year period had elapsed during which 5,037 patients had been treated surgically for biliary tract disease (nonmalignant). During the same period, 615 patients were observed to have biliary tract disease who were not operated upon. Many of these had some other condition such as cancer or advanced cardiovascular disease that was of greater immediate concern. Then too, some patients elected to postpone or reject operation. This clinical experience has been reviewed in conjunction with follow-up evaluation of many patients who have been observed for long periods. The present policies and practices in the management of patients (Table I) with biliary tract disease have been critically re-examined. The objective has been to determine the current problems that seem promising to attack in the light of the progress that has taken place during this period.

Incidence of biliary tract disease. Statistical data on the actual incidence of nonmalignant disease of the biliary tract among the population of the United States does not substantiate the impression that there has been a gradual and continuous increase. However, information of an indirect nature indicates that this disease is more common, that the diagnosis is more frequently established, and that a far greater number of individuals are operated upon than can be accounted for by the growth of the total population.

It is probable that slightly more than 10 per cent of the entire population have gallstones. The evidence for this is to be found in information published by the United States Bureau of Vital Statistics, insurance company reports, hospital audits, health group reports, and publications of hospitals such as our own, that are based on consecutive individual patient records over a period of many years. The expectation of life at birth in 1900 was estimated at 50 plus, and in 1958 it had increased to almost 70 years. This greater longevity provides the most plausible explanation for the apparent overall increase in incidence. Gallstones are rare in those under the age of 10 years. Prior to puberty, gallstone formation is usually associated with blood dyscrasias such as hemolytic jaundice. A little later, during adolescence, disturbances of metabolism may result in the formation of calculi within the biliary tract. Save for those that follow pregnancy, the total incidence of gallstones from birth until the age of 20 is so small that it is not amenable to statistical analysis. The appearance of gallstones accompanying or shortly following pregnancy is common enough that it may be considered a compli-

From the Department of Surgery, The New York Hospital-Cornell Medical Center, New York.

[1]The term patient has been used here in its broad sense to correlate the phase or stage of the disease with the surgery used and its accompanying risk as indicated by mortality rate. Thus there is some duplication because an individual with acute cholecystitis treated by cholecystostomy may later have been subjected to cholecystectomy for chronic cholecystitis and is thus listed as patient in 2 categories, and duplicated in the total.

cation or a sequela of gestation. Findings at autopsy suggest that, in the age range of from 35 to 55 years, women who have never been pregnant and men have an equal incidence of gallstones, which is estimated at from 12 to 15 per cent. Among the patients we have operated upon for gallstones, the approximate ratio of women to men is 4 to 1. Three of each 4 women had been pregnant at some time during their lives.

The age of the individual when stones were first formed and the duration of their presence have an important relationship to the disability they cause. Among young women, for example, gallstones following pregnancy are tolerated fairly well. They may cause attacks of acute cholecystitis, but these tend to subside with few of the associated complications that are so common among elderly patients. Common duct calculi and obstructive jaundice occur rarely in the younger as compared with the older group. Many factors seem to have played an important role in determining the therapy accorded patients with biliary tract disease in the past.

Because young people who had gallstones could tolerate the symptoms and infrequently developed fatal complications, physicians favored medical management or at least nonsurgical therapy. At the turn of the century, the mortality rate for cholecystectomy was estimated to be over 10 per cent. Thus there was considerable risk in operative procedures. It was also observed that as some patients in this group became older their symptoms diminished in intensity. At autopsy, calculi were found in the gallbladder and the bile ducts, and there was a wide range of liver damage, from minimal changes to cirrhosis. Others of this same group experienced an exacerbation of symptoms with the lapse of time and decided that life was intolerable, or complications developed requiring surgical relief. In either event they forsook medical management for surgical therapy.

During the past half century, the risk of operation on the biliary tract has gradually been reduced. Elective cholecystectomy for chronic cholecystitis with cholelithiasis carries a mortality rate of less than 0.5 per cent. This fact has contributed to the present attitude toward the management of patients with biliary tract disease. But there are other factors that have had an important role. The natural history and the changes associated with calcareous biliary tract disease are far better understood by the physicians of the country than ever before. Methods of diagnosis are much more efficient. The laity is also better informed through the press, radio, and television. At least 1 member of almost every family group has had gallstones, and this prevalence has stimulated further interest in the disease. It may be said that gallstones causing symptoms are at present rather quickly diagnosed. Hospital facilities and personnel are available to provide surgical therapy for most of our population. Thus, in the absence of contraindications to surgery the time interval between diagnosis and operation is being reduced. There is much evidence that removal of the gallbladder with calculi before stones appear in the common duct interrupts the disease and provides relief of symptoms in over 85 per cent of instances.

The prognosis is not as favorable for those patients who have common duct calculi or who have had a long history of recurrent episodes of biliary colic, obstructive acute cholecystitis, or cholangitis. The persistence or recurrence of infection within the biliary tract, often the result of obstruction, exacts a toll of decreased liver function and reserve that may be accumulative over the years. It is generally agreed that the longer the duration of calcareous biliary tract disease and the greater the symptoms, the more marked is the degree of liver impairment. Less well recognized is the fact that gallstones may be present for years without causing symptoms that lead to their diagnosis, and yet do result in gradual impairment of liver function. Thus it is not unusual to see an elderly patient in whom, without previous symptoms,

a complication of gallstones such as complete obstructive jaundice has suddenly developed and who has a greatly reduced liver function and reserve. Not infrequently carcinoma of the biliary tract too may occur in patients with long-standing biliary tract disease. During this period 125 patients with carcinoma of the gallbladder or extrahepatic ductal system exclusive of cancer of the ampulla of Vater have been operated upon. Over 50 per cent of those with carcinoma of the gallbladder were in the seventh decade of life. The average survival time following establishment of the diagnosis in those patients whose lesions were removed was 13 months, the range being from 4 to 39 months.

The risk of operation is greatest among older patients with long-standing biliary tract disease regardless of whether or not it has been responsible for recognizable symptoms. The number of people living beyond the age of 65 is increasing. It is at present estimated to be between 14 and 15 million, with an increment of one-half million being added annually. Biliary tract disease or its direct complications account for more abdominal operations than any other condition in this age group. With improved diagnosis and the wider acceptance of early operation, it is anticipated that the number of patients who are operated upon late in life will be decreased in the future.

Advances in diagnosis. During the 26 year period from 1932 to 1958, the diagnosis of biliary tract disease was established in over 5,600 patients in the surgical pavilions of The New York Hospital-Cornell Medical Center. It must be emphasized that the demonstration of gallstones or the failure to visualize the gallbladder by x-ray methods does not rule out other conditions as being the cause of the patient's symptoms. Thus over the years, increasing stress has been placed on the history in evaluating each patient. In 1,028 cases of acute cholecystitis confirmed by operation, the physical examination revealed crucial diagnostic data. Cholecystography, introduced by Graham and Cole in 1924, provided the single most important piece of information, direct or indirect, in determining the presence or absence of chronic gallbladder disease. Technical refinements in this procedure have given better delineation of the gallbladder and bile ducts and have thus reduced the number of repeat cholecystograms necessary to achieve visualization that was not demonstrated on the first attempt. For the most part these refinements have consisted of increasing the iodine content of the dye used and improving techniques in x-ray photography. While certain oral preparations have resulted in good visualization of the ductal system in recent years, intravenous administration of such dyes as cholegrafin has been found much more dependable and informative (2). It is no longer enough to know that the gallbladder is not visualized, contains stones, or has impaired function. Now an attempt is made to establish the presence or absence of common duct calculi and to assay liver function by determining the rapidity with which the ductal system is visualized. Since 1950, intravenous cholangiography with tomography has been a valuable aid in demonstrating common duct abnormalities, including stones and stricture. In cholangiography, cholegrafin of high iodine content is used (Fig. 1) and x-ray films are taken with a wider range technique that gives very much better visualization of the opaque material. These are but an additional refinement of Graham's original cholecystography with the intravenous use of sodium tetraiodophenolphthalein.

Diagnostic methods have made but few advances, but their application has been

TABLE I.—SUMMARY OF PATIENTS ACCORDING TO OPERATIVE PROCEDURES

Operation	*No. of patients*
A. Cholecystectomy only	4,028
B. Cholecystostomy only	134
C. Choledochotomy (with or without A or B above)	778
D. Correction of stricture and other miscellaneous procedures upon the biliary tract	97
Total	5,037

extended and improved. The demonstration of gallstones or the failure to visualize the gallbladder is viewed more critically than 10 or 15 years ago. The tendency to accept gallbladder disease, evidenced by roentgenography, as the sole cause for symptoms referable to the midepigastrium, the right upper quadrant, or both regions, is decreasing but has not altogether been overcome. Careful follow-up studies upon patients who have been treated surgically for biliary tract disease but who have had a persistence or recurrence of symptoms have influenced clinicians to realize that differential diagnosis must exclude peptic ulcer, renal disease, hiatus hernia, diverticulitis, and coronary heart disease as possible causes.

The persistence of symptoms following cholecystectomy with or without common duct exploration and the appearance of new symptoms have led to the utilization of the term, "postcholecystectomy syndrome." This, we believe to be misleading, since it connotes that the removal of the gallbladder may lead to a symptom complex. Great pains have been taken to study those patients who have had "poor results" from operation. In many instances the cause of the symptoms was something other than the gallbladder. In others, the symptoms were due to inadequate or incomplete operations which left behind common duct calculi, or a long cystic duct remnant, or even a portion of the gallbladder.

It has become apparent that a number of conditions seen in association with biliary tract disease either affect it or are affected by it. For example, coronary heart disease may be present in patients with biliary tract disease who are subject to "attacks" of biliary colic. Some patients observe that when they have symptoms from one, they are likely to have additional discomfort or disability from the other. If the gallbladder is removed, the cardiac symptoms may disappear or be greatly decreased. Our experience confirms reports of others describing electrocardiographic changes indicating a return to a normal or at least a more normal pattern after cholecystectomy. Pancreatitis of a recurrent chronic type may also be greatly improved after cholecystectomy for cholelithiasis.

Advances in preoperative preparation (general). Recent decades have seen a tremendous increase in the number of articles on the surgical treatment of biliary tract disease. In many of these, the postoperative complications have been discussed in detail with analyses of deaths. Postmortem examinations have become more frequent and are better reported than in the past. Like others, we have reviewed and published our observations of deaths in those groups in which the mortality is high, such as in the elderly, and also in those in which death resulted from the complications of acute cholecystitis. The extensive literature available has done much to make surgeons operating upon the biliary tract aware of conditions that require specific preoperative attention if postoperative complications are to be avoided.

The very young and the elderly have a much narrower margin of tolerance to the burden that surgery may impose than do those in the more robust period of life. In some patients, conditions associated with biliary tract disorder and unrelated systemic changes may actually be of such proportions that they constitute a frank contraindication. In others, these may be corrected or the operative procedure may be adapted so that it lies within the patient's capacity and serves to meet the situation, albeit temporarily. Though gallbladder disease is rare in the very young, it does occur, with or without calculi. Acute cholecystitis in infants and children is usually a complication of severe bacteremia, the focus of the infection may be anywhere; it may be an osteomyelitis or a suppurative middle ear. Years ago typhoid fever in children sometimes caused gangrenous cholecystitis with perforation and death. We observed such a patient in 1934, but have not seen one since. The recognition in the very young of gall-

bladder involvement which is secondary to severe systemic disease should prompt the surgeon to control the infection with antibiotics, if possible to delay operation until the patient is better able to tolerate it, and then to do a cholecystostomy rather than a cholecystectomy. Gallstones in children may be associated with one of the blood dyscrasias, such as hemolytic anemia with jaundice. Common duct calculi may further compound the clinical picture by superimposing an obstructive jaundice. Under such circumstances, liver function may be depressed and the burden upon the kidneys increased. Proper preoperative preparation and step-by-step or stage operative procedures may prevent postoperative complications that might otherwise be fatal. In patients from the Far East and in some tropical areas, intestinal parasites may cause obstruction and severe inflammatory reaction of the gallbladder and biliary tract. When it is feasible to control these before operation, the morbidity of postoperative complications decreases.

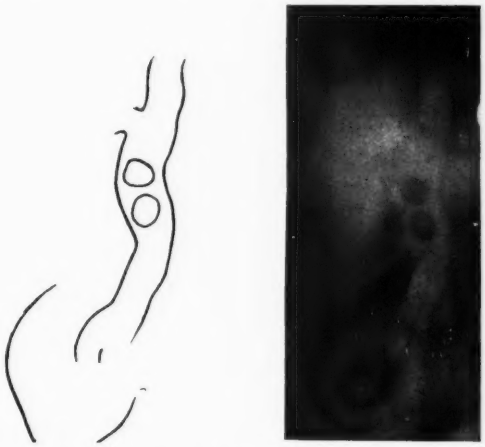


FIG. 1. Intravenous cholangiogram demonstrating common duct calculi and nonvisualization of the gallbladder.

At the other extreme of life, among the elderly, the morbidity of complications and the mortality rate are highest. The causes may be divided in two groups. First, there are those that are associated with biliary tract disease, including a wide range of changes. Some of these, such as liver damage to the extent of biliary cirrhosis, have been long in taking place. Common duct calculi may not have formed quickly, but they may suddenly produce a complete obstructive jaundice. An acute, obstructive type of cholecystitis with ischemia of the fundus of the gallbladder and free perforation into the peritoneal cavity may develop within a period of hours. These complications of biliary tract disease may impose a burden beyond the patient's capacity, and death may result in spite of heroic procedures. Secondly, there are those conditions that have developed in other systems and that are not apparently directly related to the biliary tract. For the most part, these are of a degenerative nature and are commonly considered the result of the aging process. Examples are arteriosclerosis, generalized or limited to an organ such as the kidney or to the coronary vessels. Emphysema and pulmonary hypertension, diabetes, urinary obstruction, infection, and impaired renal function are other conditions that may cause postoperative complications. The more severe and numerous these changes are, alone or in combination, the greater is the hazard of surgery to these patients. Nevertheless, without the benefit of surgical therapy their chances of survival are decreased.

The majority of patients treated surgically for biliary tract disease fall between the two extremes of age. Among 5,037 patients, 561 were 65 years old or over, and 8 were under 16. Thus, 4,468 were in the age range of 16 to 64 years, and while the incidence of postoperative complications in this group is less than in the other two, these patients constitute by far the greatest number. Many postoperative complications can be prevented. The surgeon who knows the genesis of such untoward developments will be alert to those conditions that favor them and will exercise all possible means to avoid circumstances that predispose to them. Complete

TABLE II.—SURGICAL TREATMENT OF 1,028 PATIENTS WITH ACUTE CHOLECYSTITIS

	No. of cases	*Deaths*	*Mortality rate*
A. Cholecystectomy only	801	13	1.6
B. Cholecystostomy only	104	12	11.5
C. A or B plus choledochotomy	123	5	4.06
Total	1,028	30	2.9

evaluation of each patient is the basis for preoperative preparation. Rule of thumb provisions are not always practical, but adherence to certain general principles will almost always enable the surgeon somehow to make any untoward condition more tolerable.

There are a number of conditions that are actually complications of biliary tract disease that require surgery rather urgently. These include: acute cholecystitis; complete obstructive jaundice; and either or both of these combined with a suppurative intrahepatic process, such as cholangitis, miliary abscesses, or a single large abscess; and acute intestinal obstruction due to a gallstone that has recently passed from the gallbladder through a biliary enteric fistula to occlude the intestine, usually the terminal ileum. The morbidity of postoperative complications following surgery in this group is greater than in the group in which elective procedures are performed. Although varying in mode of onset and rate of progress such acute processes are accompanied by anorexia, nausea, vomiting, elevation of temperature, and leucocytosis. Dehydration results from a reduced fluid intake and an increase in fluid requirement and loss. Electrolytes, particularly chlorides may be reduced. Carbon dioxide combining power may be increased, whether or not acidosis or alkalosis is present. Water and electrolyte balance must be achieved before any surgical procedure is embarked upon. Deficiencies should be accurately determined by appropriate laboratory procedures and corrected by a carefully calculated replacement program over a period of time within the patient's capacity and commensurate with the urgency of the acute process. In the robust individual, parenteral administration of fluid and electrolytes can be readily accomplished. In the presence of severe infection, antibiotic therapy should be employed, the specific drug being used if the organism is known or one of wide spectrum if it is not. The more nearly the patient approaches an over-all normal functional physiologic capacity, the easier it is to correct any deficiency. And conversely, the farther the patient is from this ideal state, the more difficult is the problem. A number of conditions seen in this group render correction of relatively simple problems difficult.

Sometimes vomiting or regurgitation, due either to ileus or to mechanical obstruction may be a cause of further water and electrolyte loss. It is important that this loss be measured. An indwelling nasogastric tube will make this possible and will also reduce the danger of regurgitation during induction of anesthesia. When, for one reason or another, patients are unable to void and the urinary output is of importance in replacement of fluids, an indwelling catheter should be employed.

Patients with an obstructive jaundice that is complete and has been persistent for any length of time are apt to exhibit a bleeding tendency. This is estimated with relative accuracy by measuring the prothrombin time. If there has not been destruction of the liver cells, the administration of vitamin K preparations corrects this bleeding tendency immediately. Occasionally, pruritis may accompany this type of jaundice and so disturb the patient that it is intolerable. Calcium chloride intravenously sometimes affords dramatic relief.

OPERATIVE PROCEDURES

Acute cholecystitis. With rare exceptions, the final selection of the surgical procedure to be employed upon a patient with biliary tract disease must await evaluation of the findings following the opening of the abdomen. There are instances when the patient's general condition is such that only a cholecystostomy should be done. In acute cholecystitis, the procedures that may be em-

TABLE III.—CHOLECYSTOSTOMY FOR ACUTE CHOLECYSTITIS IN 104 CASES

	With stones		*Without stones*		*Total*	
Patients	*Operations*	*Deaths*	*Operations*	*Deaths*	*Operations*	*Deaths*
Female					66	6
50 years old and over	36	4	7	1		
Under 50 years old	20	1	3	0		
Male					38	6
50 years old and over	21	5	10	0		
Under 50 years old	5	0	2	1		
Total					104	12

ployed are cholecystostomy and cholecystectomy, either of which may or may not be combined with choledochotomy. Over this 26 year period, 1,028 patients have been operated upon for acute cholecystitis (Table II). In 104 a cholecystostomy only was done (Table III), and in 4 common duct exploration was combined with it. There have been two principal reasons for doing cholecystostomy. First, the general condition of the patient included associated systemic disease that rendered him a poor operative risk. Second, conditions in the region of the gallbladder and extrahepatic biliary ductal system made identification of anatomic structures difficult. Under these circumstances, we have looked upon cholecystostomy as the procedure of choice to meet the immediate situation. It is not a definitive procedure, and it has become our practice to do a cholecystectomy later, within a matter of weeks or months, unless there is some contraindication. Our reason for doing this rests on our experience with a group of 153 patients who had had a cholecystostomy with removal of stones for either acute or chronic cholecystitis. Within 2 years, stones giving rise to symptoms had formed in the gallbladders of 50 per cent of these individuals who had not had cholecystectomy (5).

Common duct exploration in addition to cholecystostomy was performed in 4 instances. This is rarely indicated, because if common duct calculi are causing jaundice, a cholecystostomy with the removal of calculi from the ampulla of the gallbladder where they are so frequently lodged will afford decompression of the ductal system. Calculi impacted in and occluding the lower portion of the common duct will, of course, prevent bile from entering the duodenum, and thus it is urgent to prepare for the definitive procedure of cholecystectomy and choledochotomy. The mortality rate for the group of patients with acute cholecystitis who had undergone cholecystostomy either alone or combined with choledochotomy was 13 per cent. This is high not because of the procedure itself, but rather because of the condition that indicated its use. Seventy-seven, almost three-quarters of the patients, were 50 years of age and over.

When a cholecystostomy is performed, it is strongly recommended that the fundus of the gallbladder be sutured to the peritoneum and posterior rectus fascia, and that a mushroom catheter be secured within the lumen by means of a purse-string suture in order that external drainage be immediately established and well maintained as long as desired. Acute cholecystitis may occur in an acalculous gallbladder, and such was the case in 22 of these 108 patients. Their management has been the same as that for patients with gallstones. The formation of calculi following cholecystostomy for acute cholecystitis without calculi has been observed.

Cholecystectomy is the preferred definitive procedure for acute cholecystitis unless there are contraindications as mentioned previously (Table IV). This procedure alone was carried out in 801 patients with 13 deaths, or a mortality rate of 1.6 per cent. Other surgeons have repeatedly stated that they have found this to be a difficult operation and are fearful of injuring the common duct. However, it has been our experience that, if the acute inflammatory process is not of long duration, cholecystectomy is easily

TABLE IV.—CHOLECYSTECTOMY FOR ACUTE CHOLECYSTITIS IN 801 CASES

	With stones		*Without stones*		*Total*	
Patients	*Operations*	*Deaths*	*Operations*	*Deaths*	*Operations*	*Deaths*
Female					540	9
50 years old and over	225	8	4	0		
Under 50 years old	304	1	7	0		
Male					261	4
50 years old and over	128	2	9	0		
Under 50 years old	112	1	12	1		
Total					801	13

TABLE V.—CHOLECYSTECTOMY PLUS COMMON DUCT EXPLORATION FOR ACUTE CHOLECYSTITIS

	With c.d. stones		*Without c.d. stones*		*Total*	
Patients	*Operations*	*Deaths*	*Operations*	*Deaths*	*Operations*	*Deaths*
Female					96	2
50 years old and over	30	2	23	0		
Under 50 years old	29	0	14	0		
Male					23	1
50 years old and over	8	1	10	0		
Under 50 years old	3	0	2	0		
Total					119	3

In addition to the above, cholecystostomy plus choledochotomy was performed upon 4 patients with acute cholecystitis—female aged 37, male aged 56, female aged 76, and female aged 60. Stones were found in the common duct in all and death occurred in the 2 mentioned last.

performed with ready identification of the important structures in the operative field. Removal of the gallbladder is carried out by dissecting it from its bed within the liver after having identified and placed a ligature about the cystic duct and cystic artery (Fig. 2). The latter is occluded by setting one knot. Great care is exercised to avoid injury to the liver by keeping the dissection within the capsule. The cystic artery is encountered at its entrance into the gallbladder wall and divided. The cystic duct is then dissected to its true junction with the common duct, allowing it to be secured and divided under direct vision a few millimeters proximally. This method is believed to afford the greatest protection against inadvertent injury to the hepatic artery or the common duct. If the process has been existent for some time and there is considerable organization rendering dissection difficult and the identification of structures uncertain, then cholecystectomy should not be attempted, but rather a cholecystostomy should be performed.

In 119 patients with acute cholecystitis, a common duct exploration was performed in addition to a cholecystectomy. During this 26 year period, exploration of the common duct has become more frequent. The mortality rate for the combined procedure is slightly higher, 2.5 per cent in comparison to 1.6 per cent for cholecystectomy alone. The morbidity of complications after operation is also higher. Nevertheless, if the indications are present for common duct exploration, it should be performed. Because a greater proportion of elderly patients are being treated than in the early part of this period, and because the incidence of choledocholithiasis is much higher than in the younger age group, it is anticipated that common duct calculi will be found with increasing frequency in those being (Table V) operated upon for acute cholecystitis.

The most frequent complication after choledochotomy in patients with acute cholecystitis is a subhepatic accumulation that is accompanied by discomfort and pain in the right upper quadrant with an elevation of temperature and a leucocytosis. Its incidence has been reduced materially by obtaining a bile-tight closure of the common duct with a catheter or T tube in place and by placing 2 or 3 drains instead of 1 in the subhepatic area. In all patients who have had a cholecystectomy, whether for acute or chronic cholecystitis, the end of a Penrose type of drain is placed about 5 centimeters medially from the foramen of Winslow and

allowed to emerge along the course of the gallbladder bed through a stab wound placed well below the costal margin in the midaxillary line.

Particularly in elderly patients who have had exploration of the common duct in the presence of an acute cholecystitis, it has been our experience that gastric decompression adds much to the ease of the first 24 to 48 hours after operation. In the very elderly and debilitated, ulceration of the esophagus has occurred as the result of an indwelling nasogastric tube. In a few instances, the painful ulcer has healed with a narrowing of the esophageal lumen sufficient to interfere with swallowing. This experience has prompted use of a temporary transabdominal gastrostomy as described by Gilchrist which procedure insures gastric decompression with minimal discomfort. No untoward complications have resulted from its use. The gastrostomy tube is usually clamped after 24 to 48 hours and is removed on the sixth to the eighth day after operation. Leakage from the opening has not been a problem.

Chronic cholecystitis. Thirty-nine hundred and twelve patients have been operated upon in a nonacute phase of biliary tract disease. Included are those whose operations were cholecystectomy and cholecystostomy, alone or combined with common duct exploration, and those in whom only common duct exploration was done, the gallbladder having been previously removed. In addition, 97 patients with miscellaneous conditions had strictures or interruptions of the common duct.

Cholecystectomy alone was the procedure most frequently performed. In our total series of 3,227 patients with nonacute biliary tract disease, removal of the gallbladder was followed by 19 deaths, a mortality rate of 0.58 per cent. There were only 3 deaths among 1,901 patients under 50 years of age, a mortality rate of 0.16 per cent. The method of removing the gallbladder is of some importance. We have used both the approach that involves removing the gallbladder from

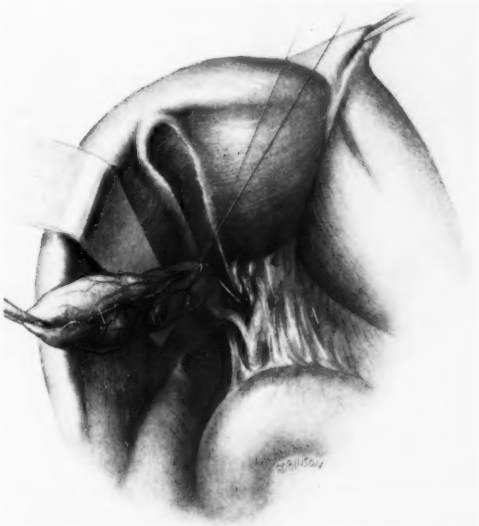


FIG. 2. The cystic artery is divided at its entrance into the gallbladder wall. The cystic duct is then readily dissected to its true junction with the common duct. This method is believed to afford the greatest protection against inadvertent injury to the hepatic artery or to the common duct.

the cystic duct toward the fundus, and the reverse, as outlined in operative procedures for acute cholecystitis, of dissecting the gallbladder from its capsule within the liver bed after first identifying the cystic duct and artery and temporarily occluding the blood vessel. It probably makes little difference which approach is employed when the surgeon has had considerable experience with operations in this area. For those who are not familiar with the numerous anomalies of this region and have had only a limited experience in biliary tract surgery, it is believed that removal of the gallbladder from the fundus toward the cystic duct is less likely to be associated with injury to the ductal system or the hepatic artery (Table VI).

If the cystic duct is not divided until its true junction with the common duct has been clearly demonstrated by dissection, there will be less likelihood that a cystic duct remnant will be left behind. When a gallbladder is removed, the cystic duct should

TABLE VI—SURGICAL TREATMENT OF 3,912 PATIENTS WITH CHRONIC BILIARY TRACT DISEASE

	No. of cases	*Deaths*	*Mortality rate*
A. Cholecystectomy only	3,227	19	0.58
B. Cholecystostomy only	30	5	16.6
C. A or B plus choledochotomy	499	23	4.5
D. Choledochotomy only	156	4	2.5
Total	3,912	51	1.3

be divided about 3 to 4 millimeters from the common duct. If a large remnant is left, calcareous material may form within it and increase to cause either a persistence or a recurrence of symptoms. If that portion of the cystic duct that contains the valves of Heister remains, then a miniature gallbladder may develop, and new calculi are prone to form. In either instance where there is calcareous material in a cystic duct remnant, it may be a cause of common duct calculi (Fig. 3).

A number of patients were operated upon who have had a recurrence or a persistence of symptoms after cholecystectomy, and removal of a cystic duct remnant has provided complete relief of the complaints. Many of these have had calculi within the remnant, and some have had calculi in the common duct in addition. So successful has been the visualization of these by intravenous cholangiography, that it is now used in all patients who continue to complain of symptoms following an operation upon the biliary tract. Because cholecystectomy is one of the most frequently performed operations in this country and is done by so large a group of surgeons with widely diversified training backgrounds, it may be anticipated that incomplete operations will be responsible for some of the "unsatisfactory" results. The findings encountered at secondary operations have included: (a) ampulla of the gallbladder; (b) cystic duct remnants up to 7 centimeters in length; (c) wall of the gallbladder with mucosal surface intact with small cyst formation; (d) a remaining small gallbladder with stones representing a portion of what had been a double gallbladder; (e) intrahepatic gallbladder; (f) intrahepatic dilatation of segment of ductal system with calculi. These are mentioned because when a cholecystectomy is performed, a careful evaluation with specific search for deviations from the anatomic normal should be carried out before the gallbladder is removed. In its removal, meticulous care should be exercised to avoid injury to the hepatic artery, the common duct, the liver, the duodenum, and other adjacent structures. Division of the cystic artery near its entrance into the wall of the gallbladder facilitates its dissection from the cystic duct. Often considerable scar tissue causes these structures to be closely adherent to each other. If, as is not uncommonly done, the cystic duct and artery are clamped together at this point and secured with a ligature, the cystic duct is not dissected to its junction with the common duct and may later be the cause of symptoms. When these two structures are separated from below upward, the artery may be easily injured. Blunt dissection of these two structures may result in the cystic artery being injured at its origin. It may also be added here that in removing the gallbladder from the fundus toward the cystic duct, the division of the cystic artery as it enters the gallbladder wall enables the operator to see and recognize vascular anomalies with little risk of injuring the right hepatic artery regardless of its origin. In elderly patients, the right hepatic artery is frequently elongated and follows a tortuous path. This circumstance allows it to lie near and parallel to the cystic duct proximal to its junction with the ampulla of the gallbladder, and as it courses caudally it gives off the cystic artery. When this obtains, it is easy to mistake the right hepatic artery for the cystic. Division of the right hepatic artery may be fatal.

The acalculous gallbladder in presumed chronic cholecystitis and cholecystectomy. From time to time one encounters at operation undertaken for chronic cholecystitis and cholelithiasis a gallbladder that contains no palpable stones and grossly is not abnormal. In most instances the clinical history has been compatible with gallbladder disease. Attempted cholecystography has failed to

visualize the gallbladder or at best has done so only faintly. Critical studies seeking other causes for the patient's complaints usually have not been made. A careful examination of the abdominal viscera at operation may be noncontributory. The immediate question requiring an answer is whether cholecystectomy should be done. In this 26 year period, a nonacute gallbladder without calculi has been removed in 155 cases. A few of the gallbladders were grossly abnormal and, on microscopic examination, showed scarring and varying degrees of chronic inflammation. On the other hand, there were many in which there was no evidence of disease. A follow-up study of 135 patients (3), some of them having been operated upon over 20 years ago, revealed that approximately 35 per cent, or roughly 1 in 3, had not had permanent relief of symptoms. It was not possible to correlate the findings at operation with the clinical results. There were some patients with apparently normal gallbladders who reported relief of complaints, and there were others who had marked changes without calculi whose symptoms were unchanged. It was our conclusion that the results of cholecystectomy in this group of patients are unpredictable. At present, when this problem arises in the operating room, one or more other surgeons are requested to examine the gallbladder. If there are gross changes of any kind, the gallbladder is removed. A cholecystectomy is also performed if it is obvious that the patient's symptoms have been due to the gallbladder or if there has been a history of jaundice. On rare occasions calculi have been found that it was impossible to palpate within the intact gallbladder. In 1 instance a gallbaldder believed to be normal was left unmolested because it was not grossly abnormal, and the history on review was not convincing. About 3 years later, a cholecystogram, the fourth, for the first time revealed several calculi of ½ centimeter in diameter. A cholecystectomy was performed and was followed by relief of symptoms.

Those patients for whose symptoms no cause is demonstrable and whose gallbladders are not removed are observed for years. Cholecystography and, more recently, intravenous cholangiography have been used to determine changes within the biliary tract. This has not been a very rewarding endeavor, and many of these patients remain clinical problems.

FIG. 3. Intravenous cholangiogram of a cystic duct remnant containing calculi.

Cholecystostomy for chronic cholecystitis. There were 30 patients in this group who underwent cholecystostomy for nonacute gallbladder disease. Most of these procedures were carried out in the early part of this period when cholecystostomy with removal of stones was performed in the elderly and poor risk patient. There were 23 patients 50 years of age and over, and 7 under 50. There were 5 deaths, a mortality rate of 16.6 per cent. In 2 instances the intended operation of cholecystectomy was abandoned and a cholecystostomy performed because of what appeared to be a coronary occlusion during the operation. In a patient with nonacute biliary tract disease, cholecystostomy should be resorted to only under unusual circumstances. The practice of removing stones from the gallbladder and performing a cholecystostomy as a definitive type of

TABLE VII.—OPERATIONS FOR CHRONIC CHOLECYSTITIS IN 3,257 PATIENTS

Operation	*Stones*		*No stones*		*Total*	
Age of patient, yrs.	*Operations*	*Deaths*	*Operations*	*Deaths*	*Operations*	*Deaths*
Cholecystostomy					30	5
50 or over	18	3	5	1		
Under 50	4	1	3	0		
Cholecystectomy					3,227	19
50 or over	1,268	13	58	3		
Under 50	1,804	3	97	0		
Total					3,257	24

TABLE VIII.—CHOLECYSTECTOMY PLUS COMMON DUCT EXPLORATION FOR CHRONIC CHOLECYSTITIS

	Stones in c.d.		*No stones in c.d.*		*Total*	
Patients, age, yrs.	*Operations*	*Deaths*	*Operations*	*Deaths*	*Operations*	*Deaths*
50 and over	184	13	107	3	291	16
Under 50	115	2	86	1	201	3

In addition to the above, cholecystostomy plus common duct exploration was performed upon 7 patients with chronic cholecystitis: 50 years and over, 3 with 2 deaths, stones recovered from common duct; under 50 years, 2 with 1 death, stones recovered from common duct; 50 years and over, 2 with 1 death, no stones recovered from common duct.

therapy was quite properly abandoned even earlier than 26 years ago by the majority of surgeons. Calculi may be expected to recur within 2 years in over 50 per cent of instances (Table VII).

Common duct exploration. The past 26 years have witnessed progress in the management of the patient with calculi in the common duct. Contributing to this have been several factors, including a better understanding of the relationship of calculi in the common duct to calculi in the gallbladder, the improvement of x-ray visualization of the ductal system by oral and intravenous administration of radio-opaque materials excreted in the bile, better methods of operative cholangiography, and meticulous attention to the operative procedure of incising the common duct, and repairing it after it has been searched for calculi.

Choledocholithiasis has come to be considered a sequela or complication of calculi in the gallbladder. Clinical reports from a number of representative clinics throughout the United States, including ours, indicate that the incidence of calculi in the common duct is low in the early phase of calcareous gallbladder disease. Calculi are seldom found in young women in whom gallstones have developed during their first or second pregnancy and who are operated upon within a few years after their occurrence. At the extreme of the older age group, almost 60 per cent of patients 90 years of age and over who have gallstones also have stones in the common duct. It is now the general concept that the older the patient and the greater the duration of stones in the gallbladder, the higher is the incidence of choledocholithiasis. Based on the reported experience of surgeons at operation and pathologists at postmortem examination, it is our opinion that 15 of each 100 patients with gallstones will have calculi in the common duct either at operation or at autopsy. For those under 50 years old, the incidence is placed at about 4 or 5 per cent, and for those 50 and over, at 20 per cent.

It is rare, indeed, to encounter calculi in the common duct with an acalculous gallbladder. If the stones in the gallbladder are small and the cystic duct is large, common duct calculi are almost invariably present. A single large cholesterol stone in the gallbladder is seldom accompanied by calculi in the common duct regardless of the patient's age, although they have been observed by us and reported by others. The fact that the association of common duct and gallbladder calculi is more frequent in older patients has stimulated efforts to obtain evidence of their presence before operation (Table VIII).

The differential diagnosis of gallstones and common duct stones not causing obstruction is difficult. If common duct calculi

do not cause complete, partial, or intermittent obstruction sufficient to produce jaundice (bilirubin of 3 mgm. per cent or less), the manifestations of pain, nausea, and vomiting may be identical.

Intravenous cholangiography has been of great assistance in the evaluation (Fig. 4) of patients who are suspected of having common duct stones. In 1953 Langecker, Harwart, and Junkmann introduced a compound, biligrafin ($C_{20}H_{12}O_{616}Na_2$), that when administered intravenously would provide a high enough opacity of the common bile duct on x-ray examination to outline it in a normal individual. Over the past several years, thousands of intravenous cholangiograms have been taken. In patients without liver disease and if the bilirubin is less than 3 milligrams per cent, the incidence of visualization is high. A great deal of information can be obtained by this procedure. In many instances, the size, number, and location of calculi may be demonstrated. It may also provide indirect evidence in favor of common duct calculi by demonstrating a dilated or enlarged ductal system. A further refinement of this method is the employment of tomography. Attempts to visualize the biliary ductal system is, of course, valueless when there is jaundice producing a bilirubin of 3 milligrams per cent or more. Intravenous cholangiography is used in all patients who are suspected of having calculi within the ductal system. Because of the high incidence of choledocholithiasis in patients in the older age group (65 years and over), an intravenous cholangiogram is taken in all who demonstrate gallstones or failure of visualization of the gallbladder on oral cholecystography.

A number of surgeons who have had considerable experience in operating upon the biliary tract have advocated that choledochotomy and search for calculi should be performed in over 50 per cent of patients. Because calculi may be overlooked and cause further trouble, this broad approach may have some justification. As the proportion of the population over 65 years old

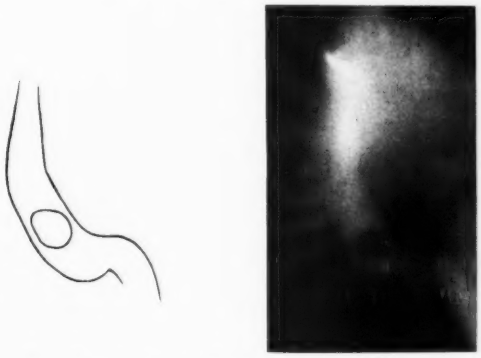


FIG. 4. Tomogram of a large calculus in a dilated common duct in a patient without jaundice 3 years after cholecystectomy.

increases, it may be anticipated that more common duct calculi will be found. It may also be asserted that the existing attitude that provides for early operation when gallstones have been diagnosed will result in more frequent interruption of the disease and that its incidence in the older age group will decrease.

Before beginning an operation upon the biliary tract, the surgeon who is well informed as to the history of the patient and all possible information that modern facilities can provide should have a pretty clear idea of whether or not the procedure will include exploration of the common duct. If this is to be undertaken, the surgeon should plan to devote as much time as is required for its complete and thorough performance. The co-operation of the x-ray department greatly facilitates the taking of cholangiograms if they are necessary. Planning of all details prior to opening the common duct and searching for stones is an important and integral part of the operation. A conviction that calculi are within the duct will do much to prevent them from being overlooked. This conviction may be based on the history, preoperative examination, or some finding at operation. Any one of several manifestations may indicate the presence of common duct calculi. The more frequently one pursues the exploration on such a basis and recovers calculi, the more thorough and persistent

will he be in his search for them in other patients. He is also quite likely to be less enthusiastic about exploring the common duct when indications are not present. It is our opinion that mere incision of the common duct and the introduction of an instrument into the duct below and above the opening without encountering calculi lead the inexperienced surgeon to go no further, with the result that calculi are overlooked and secondary operations are required.

Exploration of the common duct has most frequently been embarked upon when there was a history of: recurrent jaundice, palpable calculi within the duct, thickened wall of the common duct, dilatation of the common duct, a gallbladder containing small stones, cholelithiasis in patients 65 years of age and over, or enlargement or induration of the head of the pancreas. The last 3 are only probably associated with calculi in the common duct, and there are circumstances in which exploration will not be done. This is particularly true if an intravenous cholangiogram has demonstrated a normal common duct with passage of the dye into the duodenum.

A persistent obstruction to the flow of bile through the sphincter of Oddi causes an increase in the intraductal pressure. Normally the pressure within the common duct fluctuates between 300 and 350 millimeters of water. If this amount is increased to 375 millimeters of water, the secretory function of the liver is depressed and jaundice occurs if this situation persists for a sufficient period of time. Calculi are the most frequent cause of obstructive jaundice, but it may result from other conditions, including scar and fibrosis of the sphincter of Oddi and the intraduodenal portion of the common duct, congenital anomalies, and neoplasm. Extensive pressure upon the duct may be caused by an inflammatory or neoplastic process within the head of the pancreas or adjacent structures. Jaundice due to common duct obstruction caused by the inflammatory reaction around a duodenal ulcer is seen about once or twice a year at The New York Hospital—Cornell Medical Center.

These causes of jaundice are to be kept in mind when exploring the common duct for calculi. The presence of an obstruction of the distal portion of the common duct unassociated with calculi requires the immediate establishment of the diagnosis if proper treatment is to be initiated. Dilatation of this segment of the duct by sounds and other instruments may result in establishing an immediate but usually temporary passageway. The forceful dilatation of the narrowed terminal common duct and the sphincter results in hemorrhage and is followed by scarring. If the obstruction is due to scar formation, its disruption by dilatation will be followed by increased scar formation. If it is due to cancer of the lower end of the duct or the ampulla of Vater, then the correct diagnosis is not often made. It is for these reasons that indirect dilatation has been replaced in the present series by transduodenal incision and direct inspection of the ampulla of Vater. This method affords an opportunity to determine the correct cause and do what may be indicated. Careful closure of the duodenal wall is seldom followed by any untoward symptoms.

Complications following operative procedures upon the biliary tract. After operations upon the biliary tract complications or sequelae may occur. These are a cause of added disability and contribute to the mortality rate. They vary in significance, some causing only minor discomfort, others leading to prolonged invalidism or death. The more critical that one is in searching for complications, the more frequently he will find them. In this endeavor, surgeons differ greatly. From our experience, the incidence is believed to be about 15 per cent. The mortality rate arising from these complications was 1.7 per cent in 5,037 patients.

Many of the more frequent complications can be prevented. The first step in their prevention is to realize that they may occur and to anticipate their appearance. Equally important is an understanding of their eti-

ology and genesis. A surgeon aware of the origins of complications will seek these out and correct them insofar as it is possible. Those factors that are the result of a lack of meticulousness, haste, and carelessness he can control. Those factors which he cannot influence must be evaluated as to the risk or hazard that they constitute in comparison to that of the condition or disease of the biliary tract for which operation is being considered.

The morbidity from complications and the mortality associated with biliary tract surgery have decreased over the past few decades in a proportion comparable to that in the field of surgery as a whole. The safety of surgery and the ease with which it may be accomplished from the patient's viewpoint have been markedly advanced. A large proportion of those complications that are specifically related to surgical operations upon the biliary tract are the result of the interruption of the normal flow of blood or bile in their normal channels. Hemorrhage, always a hazard in surgery, may be caused by injury to the cystic artery, the hepatic arteries or anomalous branches, the gallbladder bed, the liver, the vessels of the common duct or the abdominal wall. It also occurs as a result of a vitamin K deficiency in patients with jaundice and liver damage.

Bile may escape into the peritoneal cavity from the common duct, the cystic duct remnant, small radicles extending directly from the liver to the gallbladder, and breaks in the continuity of liver substance, resulting in peritonitis. If the rate of escape is slow, there is a strong likelihood that the reaction to bile of the omentum and the peritoneal surface of the viscera adjacent to the area of operation will prevent its escape into the remainder of the abdomen. Thus a localized accumulation of bile may occur. If escape of bile into the peritoneal cavity is rapid then its spread is diffuse. Free bile within the peritoneal cavity may cause a fall in blood pressure and the clinical manifestations of shock, and may terminate in death. While this is the result most to be feared, large quantities of bile may also escape into the peritoneal cavity causing marked abdominal distention but little evidence of peritoneal irritation and no changes in blood pressure.

When bile escapes from its normal course, it either accumulates near its source, spreads over the peritoneum, or reaches the exterior, usually by means of a drain. If the local accumulation persists and increases, then it may form a tract to the exterior. When bile is free in the peritoneal cavity, operation may reveal its source and correct the condition by redirecting its flow into the intestine or diverting it to the exterior. In all 3 instances, however, a biliary fistula may result. This complication may be burdensome to manage and difficult to correct, but it reduces the seriousness of the situation by replacing a condition associated with a high mortality rate by another with a much lower mortality rate.

An external biliary fistula that develops after an operation upon the biliary tract is the result of an interruption of the flow of bile through its normal path from the liver to the duodenum. It may occur after any operation upon the biliary tract, and the cause may be the nature or extent of the biliary tract disease, or distortion or injury resulting from the surgical procedure.

The appearance of jaundice following an operation upon the biliary tract is usually an indication of a serious complication. The nature of its onset, its intensity, and severity or degree of systemic manifestations that may accompany it provide a basis for suspecting its etiology and probable course. The causes are numerous and include obstruction of the extrahepatic ductal system, cholangitis, intrahepatic cholangiolitic hepatitis, hepatic failure, intrahepatic metastatic carcinoma, viral hepatitis, toxic hepatitis due to medications, blood dyscrasias, transfusion reaction from improperly matched blood, pyelophlebitis, and other more rarely encountered conditions.

The most frequent cause of jaundice fol-

lowing cholecystectomy or operations upon the biliary tract is obstruction some place along the extrahepatic ductal system. Calculi, infection, neoplasia, and scarring may cause such obstruction not only within the system, but at its outlet into the duodenum at the ampulla of Vater. Lesions extrinsic to the hepatic ducts such as expanding lesions of the pancreas, carcinoma, or pancreatitis may encroach upon the lumen and produce an obstructive jaundice. Occasionally, a neoplasm of the duodenum may occlude the biliary outlet. During cholecystectomy injury of the common duct that results in its narrowing or complete interruption occurs often enough so that it should always be considered as a possible cause whenever jaundice appears within a day or two after operation. Sometimes trauma to the ductal system may not immediately cause occlusion, and days or weeks elapse before there is jaundice. In the surgical treatment of patients who have sustained injury to the common duct the operative mortality rate has been high in our experience. There were 8 deaths in 97 patients (mortality rate 8.2 per cent) who came to us for correction of a condition believed to be related to an operative injury—2 deaths in 42 patients under 50 years old and 6 deaths in 55 patients 50 years old or over. In addition the disability among these individuals is very great.

SUMMARY

A review is presented of 5,037 patients treated surgically for non-malignant disease of the biliary tract during a 26 year period. During this time, there has been a wider acceptance of surgical therapy for this malady. Contributing to this trend has been a reduction in the morbidity of complications and in the mortality rate. From the patient's point of view, surgery is accomplished with greater ease as well as increased safety. It is contended that this trend will continue as the time interval between the establishment of diagnosis and operation is further reduced. Evaluation of patients with anticipation of possible complications resulting in better preoperative preparation and meticulous attention to the technical steps involved should improve the results in the future. The difference in the mortality rate of 0.5 per cent for 2,712 patients under 50 years of age and 3.2 per cent for 2,325 patients 50 years of age and older treated surgically for nonmalignant disease of the biliary tract emphasizes the importance of early diagnosis and early operation.

REFERENCES

1. Gilchrist, R. K. Postoperative decompression of the stomach and jejunum by gastrostomy. J. Am. M. Ass., 1953, 152: 232.
2. Glenn, F., and Johnson, G., Jr. Intravenous cholangiography; correlation with operative findings in 72 patients. Surg. Gyn. Obst., 1957, 105: 473.
3. Glenn, F., and Mannix, H., Jr. The acalculous gallbladder. Ann. Surg., 1956, 144: 670.
4. Graham, E. A., and Cole, W. H. Roentgenological examination of the gallbladder. New method of utilizing intravenous injection of tetrabromphenolphthalein. J. Am. M. Ass., 1924, 82: 613.
5. Hays, D. M., and Glenn, F. The fate of the cholecystostomy patient. J. Am. Geriat. Soc., 1955, 3: 21.
6. Langecker, H., Harwart, A., and Junkmann, K. 2,4.6—Trijod—3—Acetaminobenzoesaure-Abkoemlinge als Konstrastmittel. Arch. exp. Path., Lpz., 1953, 220: 195.

A CLINICAL EVALUATION OF POSTOPERATIVE NASAL GASTRIC SUCTION

JOHN H. MEHNERT, M.D., F.A.C.S., MAURICE J. BROWN, M.D., F.A.C.S., BENJAMIN WOODWARD, M.D., F.A.C.S., ERIC PAETKEU, M.D., and PAUL B. DONOVAN, Ph.D., San Diego, California

GASTRIC SUCTION has been of tremendous benefit in the treatment of certain gastrointestinal diseases, particularly bowel obstruction. This fact has led to its widespread utilization, especially postoperatively during the period of relative ileus. However, recent articles have indicated serious complications that can occur from the presence of an indwelling gastric catheter. For example, the incidence of esophagitis and respiratory complications has definitely increased with the use of the Levin tube.

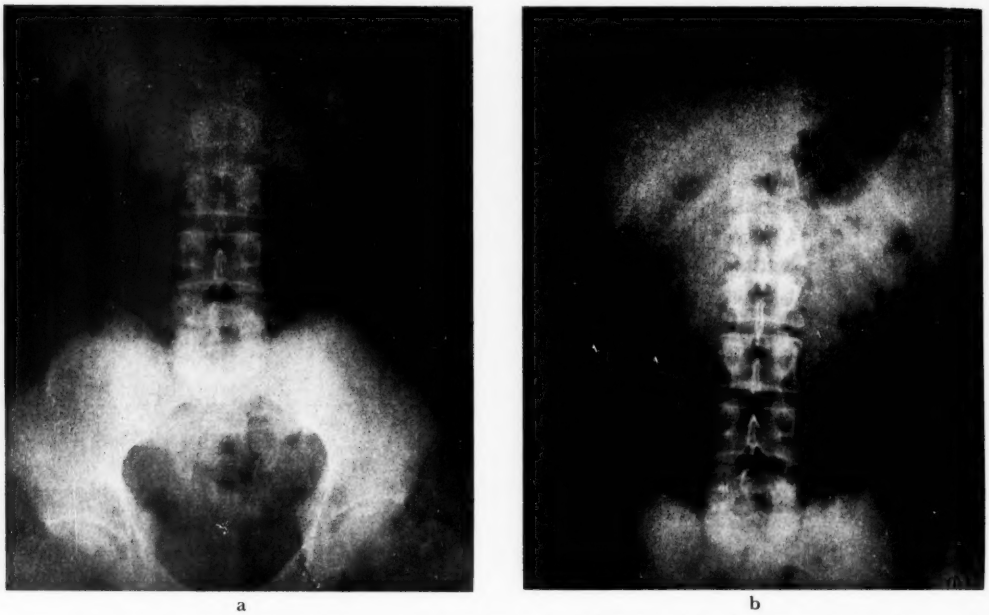
Gerber and his associates have shown that after an uncomplicated laparotomy, routine insertion of a nasal-gastric tube is inadvisable. He indicates that the relatively small amount of gastric fluid withdrawn through an indwelling tube can be readily absorbed by the postoperative gut even in the presence of ileus, and that air ingestion is minimal if fluids are withheld.

The following study is an attempt to evaluate this contention further by measuring fluid, air, and electrolyte withdrawal through postoperative gastric suction tubes, both in the fasting state and when fluid intake is allowed.

In order better to understand the function of a gastric suction tube, let us consider a few facts concerning the normal physiology of the upper intestinal tract. A fasting volume of saliva and gastric fluid is continually secreted, the average quantity of each being about 1 liter, although there are wide individual variations. In the normal fasting state this fluid is passed readily and immediately into the small bowel where it is reabsorbed. An indwelling gastric tube is able to capture only a portion of this fluid as it passes through the stomach.

While average secretory volumes are well known, the amount of air swallowed in the fasting state and during fluid intake has not been determined. An attempt was made to discover, first, whether an appreciable quantity of air can be swallowed by the average person without concomitant fluid intake and, second, whether a significant amount of air is ingested with fluids. A roentgenogram of the abdomen of one of the authors, taken after a fasting period of 12 hours, revealed a scatter of gas in the large intestine and a small gastric air bubble. An effort was then made to swallow large volumes of air by constant dry swallowing over a period of approximately 20 minutes. Then, a second roentgenogram of the abdomen revealed a moderate increase in the volume of gastric air with air beginning to enter and scatter through the small bowel, but the amount was surprisingly small for the considerable swallowing which was done, as can be seen in Figure 1.

An attempt was next made to determine whether there was any constant relationship between the amount of fluid intake and incidental air ingestion. Healthy adults were intubated and required to swallow 200 cubic centimeters of water. A measurement was then made of fluid and air recovered through normally functioning tubes. Though variations occurred, even on the same person in separate "runs," the average amount of drainage was remarkably constant and revealed that about 1.3 cubic centimeters of air were recoverable for each cubic centi-



a b

FIG. 1. Roentgenograms of abdomen: a, after fasting for 12 hours, and, b, after dry swallowing for 20 minutes. Note the accumulation of gastric air and scatter of air in small bowel after swallowing.

meter of water swallowed. In every instance there was air intake during the act of swallowing the liquid, and the volume of air recovered was regularly of greater volume than this fluid intake. No relationship existed between the air volumes and the manner in which the fluid was taken (sipping one swallow at a time or taking the entire amount without stopping).

METHOD

In an attempt to obtain further data on gastrointestinal secretion and air intake, 27 postlaparotomy patients were divided into two groups on a random basis by hospital number.

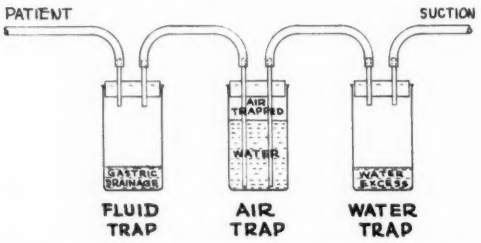


FIG. 2. Fluid-air trap apparatus. The separate water and air traps make separate measurement of these volumes possible. A tight seal must be maintained.

In one group water intake was allowed and encouraged, while in the other nothing was permitted except for occasional mouth rinses. Levin tubes had been inserted into all of the patients either during operation or immediately thereafter. The fluid and air return through these tubes was measured by a special apparatus (Fig. 2).

In that group of patients in whom water was allowed, the oral intake and the irrigation volumes were carefully measured. By subtraction of this total from the entire fluid drainage it was possible to obtain a measurement of the amount of recoverable gastrointestinal secretion. When nothing was allowed by mouth it was assumed that all fluid drainage was of gastrointestinal origin. If the tubes were irrigated, precautions were taken not to introduce air into the suction system. In all other respects the patients were given routine postoperative care. In this way an evaluation was made of the

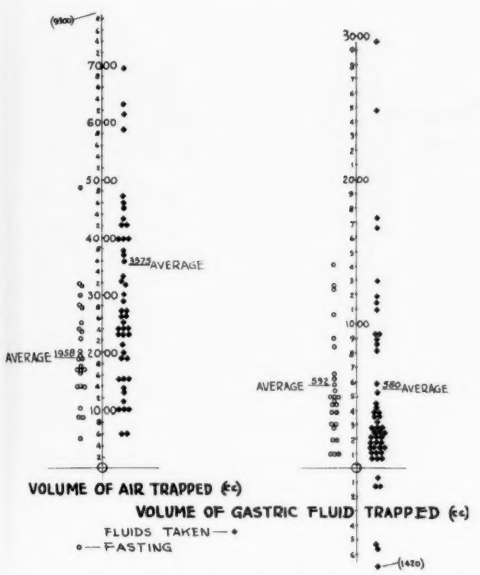


FIG. 3. Comparison of volume of air and gastric fluid recovered in 2 groups. Each symbol represents an individual 24 hour determination. The volumes of air and fluid obtained in the fasting group are quite constant; much wider spread of fluid drainage and greater volume of air accumulation exist in fluid intake group.

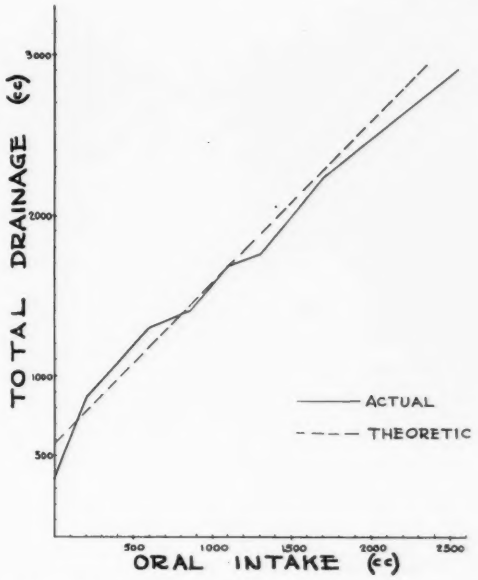


FIG. 4. Comparison of theoretic and actual efficiency of gastric suction. The actual volume of fluid withdrawn (indicated by solid line), closely approximates the theoretic recovery (indicated by dotted line), revealing an excellent efficiency of the tubes in those comprising the oral intake group.

function of the Levin tubes in regard to removal of gas, fluid, and electrolytes.

RESULTS AND INTERPRETATIONS

Fasting group. Ten postoperative patients were studied in whom all oral intake was withheld. The volumes of air and fluid drainage were quite uniform and averaged approximately 600 cubic centimeters of gastric fluid and 2,000 cubic centimeters of air removed in each 24 hours (Fig. 3). Of special interest is the fact that air volumes removed were regularly of this magnitude, representing a consistent volume of air taken into the fasting stomach. The 600 cubic centimeters of fluid drainage do not represent the total gastric and salivary output but rather indicate the ordinarily recoverable gastrointestinal fluid in the postoperative state.

Quantitative determinations of the sodium content of the aspirated fluid in this group of patients revealed that an average of 42 milliequivalents was lost each 24 hours. The average concentration of the sodium was 65 milliequivalents per liter which is slightly hypertonic as compared with the usual fasting gastric secretion. The average chloride content each 24 hours was 70 milliequivalents with a concentration of approximately 116 milliequivalents per liter, slightly lower than normal. The increased sodium content is explainable on the basis of regurgitated duodenal fluid containing a higher sodium concentration. The lowered chloride probably is due to the relative achlorhydria seen in the older patients comprising this group. There also may be a direct hypochlorhydria from the postoperative state. The total electrolyte losses were not of a large magnitude and would be replaceable by an infusion of approximately a half liter of physiologic saline.

Fluid intake group. Another group of 17

FIG. 5. Effect of fluid intake on gastric secretion. No appreciable rise in gastrointestinal fluid withdrawal occurs as the fluid intake is increased in the group allowed water.

postoperative patients was investigated who ingested up to 3 liters of water each 24 hours. When fluid intake was correlated against the total volume of drainage, a constant and direct relationship appeared although there was a wide individual variation. The total fluid drainage usually approximated the oral intake plus the anticipated fasting gastric volume, indicating the excellent efficiency of the suction apparatus.

Frequently, however, the total drainage volume was less than the oral intake, with no accompanying evidence of gastric fluid accumulation, indicating gastrointestinal motility and absorptive power in these patients even during the immediate postoperative period (Fig. 4).

Increasing the water intake to 3 liters in 24 hours resulted in no appreciable rise in recoverable intestinal secretion (Fig. 3) indicating minimal stimulation by fluid ingestion (Fig. 5). In Taylor's series in which the patients were required to drink 3 liters each 24 hours, the average gastrointestinal fluid output was only 14 per cent greater than the fasting volume. In the usual limits of oral water intake, then, there is very little stimulation of salivary or gastrointestinal fluid secretion.

Determinations were made of electrolyte losses as the fluid intake increased. The total chlorides failed to reveal any significant increase, while the sodium rose from a fasting average of 41 milliequivalents to 65 milliequivalents when 2 liters of fluid were taken (Fig. 6). Taylor found only a 36 per cent rise in chloride loss in unoperated upon patients when he forced 3 liters of fluid each day. It appears from Figure 6 that with intakes of less than 1 liter, the increase in electrolyte withdrawal is insignificant.

The total volume of air trapped was considerably greater in this group of patients as contrasted with those in whom no water was allowed (Fig. 3). An evaluation of the volume of air withdrawn with increasing oral intake was made, and a definite correlation was found to exist. Air recovery was almost 5 liters in individuals who drank 2,000 cubic centimeters per 24 hours, representing marked increase as compared with an average of 1,600 cubic centimeters recovered from the patients in this group who took no water (Fig. 7). This averages about 1.3 cubic centimeters of air recovered for each cubic centimeter of water taken, correlating completely with our findings in normal subjects. These findings demonstrate vividly that air ingestion is a major factor when large volumes of fluid are allowed.

Although the need for gastrointestinal decompression is the primary consideration in tube usage, it is not the only one. Considerable discomfort accompanies the maintenance of gastric intubation. We evaluated several factors of patient discomfort including general tube discomfort, thirst, sore throat, nausea, and vomiting. Approximately 75 per cent of the patients had distress from the tube, and in general, sore throat and thirst paralleled in intensity the tube

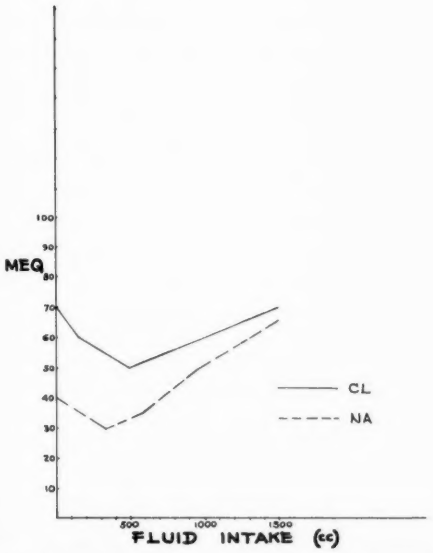


FIG. 6. The sodium and chloride losses with increasing oral intake. The sodium loss increases to a moderate degree as fluid intake was increased to 1,500 cubic centimeters. No increase in chloride loss was found in these patients. The electrolyte loss is not appreciably increased by fluid intake of 1 liter or less.

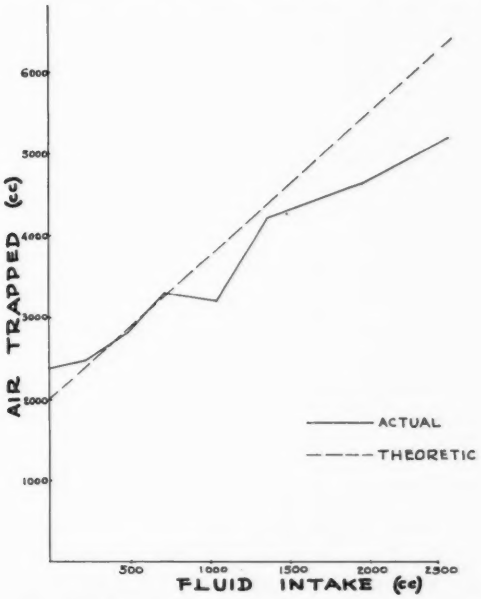


FIG. 7. Effect of oral fluids on air intake. A rise occurs in air ingestion as an increasing amount of fluids is taken. The actual volumes obtained (solid line) correspond closely to the theoretic volume determined from volunteer subjects. Air accumulation is considerable when large volumes of fluid are taken.

discomfort. It was interesting that there was no significant difference in thirst and tube discomfort when comparing patients on fluid intake with those receiving nothing by mouth. Sore throat was significantly more frequent in the fasting group, probably a reflection of the constant dryness of the oral and pharyngeal mucosa. Although tube insertion is frequently considered a panacea for postoperative nausea and vomiting, approximately 45 per cent of the patients had some nausea, and 20 per cent vomited while the tube was in place. Probably postoperative vomiting is often of reflex origin since there was no indication that the tubes were malfunctioning, and emesis occurred most frequently on the operative day, when one would expect less gastric accumulation.

CONCLUSIONS

While the conditions are not completely comparable with nonintubated patients, it appears that the average person taking no fluids postoperatively swallows approximately 2 liters of recoverable air and accumulates in the stomach about 600 cubic centimeters of recoverable salivary and intestinal secretion each day. Gerber's large series of unintubated postoperative patients from whom fluids had been withheld indicated that the fasting intestinal output is readily absorbed and that gastric air accumulation constitutes no problem under these conditions. Our experience has paralleled his in this regard.

With increasing oral intake considerable air and fluid can be accumulated because of the decrease in gastrointestinal motility postoperatively. Somewhere a point of decompensation is reached, dependent upon the degree of ileus present. An unlimited amount of fluid by mouth would seem to be contraindicated for this reason.

If, however, 2 liters of air are accommo-

dated by the usual postoperative fasting stomach without difficulty, the additional liter of fluid and air accumulated by the drinking of 400 cubic centimeters (2 glasses) of water would probably cause no severe distress, while the water intake would improve morale and tend to prevent soreness and dryness of the throat.

The unintubated postlaparotomy patient taking small amounts of fluid by mouth will have less fluid and electrolyte loss, less chance of respiratory infection or other tube complications, be more comfortable, and more easily ambulated. With occasional exception, in our clinical experience these patients have no more abdominal distress or vomiting than a similar intubated group. For these reasons we believe that this is the most physiologic and most humane management for the average uncomplicated patient.

Under circumstances in which insertion of a tube is necessary, it appears that the increase in gastric secretion and electrolyte loss occasioned by the washing and stimulating action of a liter or less of water is insignificant. The chief danger of fluid intake is in the accumulation of large volumes of water and air ingested, necessitating careful supervision to insure constant tube function when fluid is allowed.

REFERENCES

1. Gerber, A., Rogers, F. A., and Smith, L. L. The treatment of paralytic ileus without the use of gastrointestinal suction. Surg. Gyn. Obst., 1957, 107: 247–250.
2. Taylor, F. W. Electrolyte loss by postoperative nasal gastric suction. Arch. Surg., 1953, 66: 538–544.

MANAGEMENT OF ANTERIOR CRANIAL AND UPPER FACIAL INJURIES

GORDON S. DUGGER, M.D., and ERLE E. PEACOCK, JR., M.D.,

Chapel Hill, North Carolina

SEVERE TRAUMA to the anterior cranium and upper face presents a combination of difficult diagnostic and therapeutic problems and a threat of grave complications. Although intracranial and facial injuries are usually relegated to different surgical specialists, the principles of successful management in both areas are so interrelated that an unusual overlap in training and experience is desirable. Only rarely does one individual possess sufficient experience in the several disciplines required to treat all aspects of these injuries. Thus optimum treatment is usually the result of the combined efforts of the neurosurgeon, the general, or plastic surgeon, and at times an ophthalmologist. Therefore, failure of any one of these surgeons to appreciate the interrelation of injured tissues outside of his field may result in improper timing of restorative procedures. Knowledge of the details of treatment and the correct timing of surgical manipulations is, in our opinion, the essence of successful management of complex craniofacial wounds. Conversely, incorrect timing has often led to such distressing complications as blindness, cosmetic deformity, asphyxia, and overwhelming intracranial infections.

EARLY CARE

Important items in the early care of patients with anterior cranial and upper facial injuries are provision of an adequate airway, protection of the cornea, and control of hemorrhage. Fatal errors in airway management can occur during transportation in a supine position. Deeply unconscious individuals are not only unable to clear their airway, but often have such shallow respirations that no sound or movement warns of impending asphyxia. Furthermore, patients with cerebral injuries tolerate anoxia poorly, and even temporary airway obstruction may be fatal. Cerebral injury with unconsciousness and upper airway embarrassment is a dangerous combination, and patients in this condition should be transported in a prone or lateral position, with constant supervision. Severe intraoral hemorrhage, extensive soft tissue edema and subcutaneous emphysema, and multiple comminuted fractures of the mandible and maxilla which allow the tongue and surrounding soft tissues to collapse on the glottis constitute the principal indications for tracheotomy.

Proper care of the cornea consists of meticulous removal of all foreign debris and provision of adequate soft tissue coverage. As little as 20 minutes' exposure of the cornea can lead to ulceration and subsequent opacity. Lacerations of the eyelid should be sutured immediately; if the lids are missing, a local forehead flap should be rotated over the cornea for temporary coverage. From the time an exposed cornea is noted, until final coverage is possible, an attendant should keep the cornea moist with a continuous saline drip. Since it may be necessary to leave the eye closed for an extended period, it is particularly important in unconscious patients to be certain at the time of blepharoplasty or application of dressings that there are no internally de-

From the Department of Surgery and the Division of Neurosurgery, University of North Carolina School of Medicine and the North Carolina Memorial Hospital, Chapel Hill, North Carolina.

viated eye lashes, irritating sutures, or retained foreign bodies.

Hemorrhage is seldom a serious problem in upper facial injuries, although extensive fractures through the sphenoid bone and foramen lacerum will be rapidly fatal if the internal carotid artery is lacerated. Upper nasal and sinus hemorrhages can usually be controlled by an accurately placed internal pack. Severe scalp lacerations occasionally cause profuse hemorrhage and severe shock. In the absence of extensive scalp wounds, however, the cause for prolonged shock probably will be found in some region other than the anterior portion of the face and cranium.

Other therapy during the early phase of frontocranial wounds is directed toward prevention of edema, and providing temporary stabilization of fractures, and proper cleansing and dressing of soft tissue wounds. Elevation of the head and application of cold compresses to the orbital region are helpful in preventing edema. Eye signs are important in following the neurologic status, therefore prevention of periorbital edema is helpful. Drugs such as hyaluronidase® and phenergan® are reported to be of value in preventing postoperative facial edema, but have been disappointing to us in treating edema after trauma has already occurred.

Small soft tissue wounds should be sutured immediately and all wounds should be dressed with a firm, fine mesh, gauze dressing. Unstable lower jaw fractures can be temporarily stabilized with a four-tail bandage or Barton type head dressing until the neurologic status permits reduction and permanent fixation. The oral and nasal cavities should be cleansed repeatedly by using suction and small amounts of a bland mouth wash to flush debris. Following tracheotomy, the mouth and nasal cavities should not be neglected, for this permits an ideal situation for the development of osteomyelitis when there are compound fractures extending into these cavities. The lips and nasal mucous membranes should be protected with a bland ointment or mineral oil to prevent excessive drying. In patients with cerebrospinal fluid rhinorrhea, blood clots and encrusted secretions blocking the external nares may be gently removed to insure free drainage, but nothing should be instilled into the nasal cavity. Blowing the nose, coughing, sneezing, and straining must be avoided to prevent forcing contaminated material into the cranium.

Protection against tetanus should be provided and a minimum of 1,000,000 units of aqueous penicillin every 6 hours, complemented by a broad spectrum antibiotic, should be started immediately.

DIAGNOSIS

Injury to the head and face from acceleration and deacceleration forces often produces serious damage to the brain. The possibility of the occurrence of subdural or extradural hemorrhage after injury to the anterior portion of the head and the face must be kept in mind, although, in our experience, the development of hematomas of significant size are rare. Acute subdural hemorrhage usually is associated with severe brain damage and thus presents a serious danger. The type of violence responsible for injury to the anterior portion of the head and upper part of the face is apt to cause contusion and laceration of the brain, particularly in the anterior poles of the frontal and temporal lobes. Intracerebral hematomas are rare in our experience.

In evaluating a patient with brain damage, knowledge of the level of consciousness and notation of focal signs soon after injury are valuable for comparison with future observations.

Roentgenograms are of limited value in diagnosing fractures of the middle and upper third of the face. The delicate membranous bones of the upper part of the face overlie the dense basioccipital bone on an anteroposterior film of the skull so that facial fractures may not be visible. A Waters' view of the face should be obtained, as this view is helpful in visualizing the orbital rims and

zygomatic arches. Roentgenologic demonstration of a cloudy antrum or subcutaneous emphysema is of indirect assistance in diagnosing fractures that may not be visible directly. Physical examination provides direct information in many face fractures and roentgenograms are only confirmatory. In addition, knowledge of the usual mechanisms of face fractures is helpful in that the examiner's attention is directed to those areas where fractures occur in familiar patterns.

Fractures of the zygoma are rare. The zygoma is the heaviest bone in the face and, when subjected to direct trauma, it usually dislocates from the zygomatic process of the temporal bone, the angular process of the frontal bone, and the maxilla. Following separation, the heavy zygoma acts as a missile, moving through the center of the face, where it may smash the fragile bones in its path. In diagnosing this injury, external appearance or palpation of a single zygomatic arch is not reliable, as edema or hematoma may mask alterations of the lateral facial contour. A dislocated zygoma sometimes locks in a rotated depressed position so that crepitation cannot be elicited. Anesthesia of the cheek and upper lip results from avulsion or contusion of the inferior orbital nerve. Abnormal limitation of motion in the temporomandibular joint is suggestive of a depressed zygomatic arch. Occasionally, the offending fragment can be palpated by placing the tip of the little finger into the external auditory canal. Frontalis muscle paralysis may occur with fractures of the zygomatic arch due to injury of the upper branch of the facial nerve where it crosses the arch.

Single fractures of the rim of the orbit are rare. The superior ridge is dense bone, and direct trauma results in crumbling and compression rather than separation of intact fragments as in the inferior rim. Large fragments of the lateral and inferior rim tend to separate and rotate outward and downward. Subcutaneous emphysema indicates fractures which have extended into the paranasal sinuses or nasal cavity.

Fractures of the nasal bones are usually detected by asymmetry of the face and by crepitation on light palpation. Fractures and dislocations of the nasal septum can occur without visible fractures of the external portion of the nose, and these should be recognized and treated.

Fractures beginning in the frontal bone may pass through one or both walls of the frontal sinus and extend into the cribriform plate of the ethmoid, the roof of the orbit, and occasionally the optic canals and sphenoid sinus. When the blow is directed toward the face, the impulse may be transmitted through the facial bones to the base of the skull and fracture the thin walls of the ethmoid and cribriform plate. Fractures of the cribriform plate are particularly dangerous because of the possibility of dural tears. The dura is thin in this area and is anchored to the bone as it extends along the olfactory nerves. Fractures of the frontal and ethmoidal sinuses are always compound fractures which expose the brain to potential serious infection. A fracture should be suspected in the presence of laceration or contusion of the forehead, ecchymotic tissue about the eyes, temporary or permanent loss of smell, damage to the optic and oculomotor nerves, and subcutaneous air or fluid over the forehead.

Although fractures of the frontal, ethmoidal, and sphenoidal sinuses may be simple to diagnose, lacerations of the dura may not be so obvious. Unequivocal signs of dural laceration are cerebrospinal fluid rhinorrhea and intracranial aerocele; either of which may be followed by meningitis or cerebral abscess.

Though x-ray films of the skull may be disappointing in determining the extent of fractures in the anterior cranium and sinuses, they are often helpful in suggesting dural lacerations. Intracranial projections of bone fragments from the frontal sinus or orbital roof (Fig. 1) strongly suggest dural lacerations, as do wide gaps in fracture lines. A fracture in the posterior wall of the frontal sinus which gives the appearance

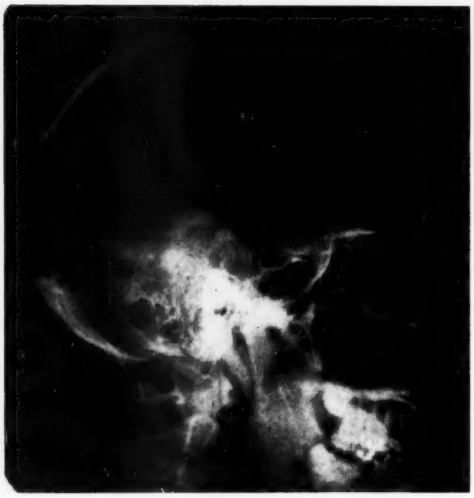


FIG. 1.

FIG. 2.

FIG. 1. Roentgenogram to show a fracture of both walls of the frontal sinus and severe fragmentation of the orbital surface of the frontal bone. The fracture had caused extensive lacerations of the dura and brain.

FIG. 2. Roentgenogram showing a fracture in the temporal region which passed forward and entered the frontal sinus. The fracture which entered the sinus widened as it descended and was associated with a dural laceration.

of an increasingly wide gap extending toward the anterior ethmoids is likely to overlie a dural laceration. A V-shaped fracture, beginning in the region of the base of the external angular process of the frontal bone with the posterior limb extending through the anterior temporal region and the anterior limb, then passing across the forehead to enter the frontal sinus on either side, as described by Cairns, is also suggestive of a dural laceration (Fig. 2). Fractures coursing from one anterior fossa to the base of the skull on the opposite side, displacement of the frontozygomatic synosteosis, or tilting of the crista galli are also highly suggestive of dural tears.

OPERATIVE MANAGEMENT AND TIMING

Simultaneous injury of the eyes, facial structures, brain, and meninges creates a problem in correct timing of operative procedures. In some carefully selected cases it may be safe to proceed at once with definitive surgery designed to repair all of the damage in one operation, while in other cases multiple procedures are advisable. In these cases, proper timing and proper selection of operative procedures require sound judgment; brain damage usually takes precedence over all other considerations. With the exception of extradural hemorrhages and temporal lobe herniations, immediate operation for intracranial damage is seldom necessary.

Membranous bone heals by fibrous union, and fractures of the delicate medial wall of the orbit and insertion of the medial canthal ligament must be reduced before fibrous fixation occurs. If depth on either side of the nose is not restored within 5 or 6 days, an important individualizing feature will be permanently lost. A dislocated or fractured zygoma can be reduced as late as 9 days, but reduction may be difficult. An irreparably damaged eye does not have to be enucleated before 5 days, particularly if local and systemic antibiotic therapy is adequate. Sympathetic ophthalmitis becomes a hazard after 5 days; therefore further delay is justifiable only in unusual circumstances. Properly dressed soft tissue wounds can be repaired 4 or 5 days after injury.

Thus, it is apparent that repair of even the most extensive composite wounds of the frontal region involving the eye, sinuses, soft tissue, and facial bones can be delayed up to 5 days if necessary. Edema will be subsiding in many frontal lobe injuries by this time, but if general anesthesia is still deemed

unsafe, enucleation of a damaged eye or reduction of a fracture of the medial canthus should be done without anesthesia, as further delay may result in undesirable complications.

Internal fixation of facial fractures in unconscious or unco-operative patients is preferable to external apparatus. Protruding hooks, head caps, and complicated external splints not only are difficult to keep properly adjusted but may become instruments of destruction during an excited state. Detailed descriptions of the technique for internal reduction and fixation of facial fractures are available in the surgical literature. Essentials of proper management are as follows:

Orbital rim fractures should be individually reduced through separate incisions, if necessary, and then fixed by direct wires. Dislocation of the zygoma should be reduced with a bone hook and fixed by cantilever action with a transverse Kirschner wire, as shown in Figure 3. Fractures of the nasal bones and inner canthus avulsions cannot be held satisfactorily with an external splint. Transverse wires passed through the fracture lines in the nasal bones and tied over padded lead plates on either side of the nose provide the surest restoration of depth on the sides of the nose. Detailed descriptions of these procedures have been published by McDowell, Brown, and Fryer. Internal nasal packs and transverse wires must never be applied until rhinorrhea has been treated. Direct wiring of individual fragments or internal Kirschner wire fixation of linear fractures is preferable to Stader splints or interdental appliances in unconscious patients with jaw fractures. Interdental fixation may be unavoidable for maxillary fractures, but requires a tracheotomy in unconscious patients. In summary, when possible, internal fixation by direct wiring to a higher or adjacent stable bone is preferable to either external splinting, interdental appliances, or intracavitary packs.

FIG. 3. Postoperative roentgenogram to show fixation of a fractured left zygoma by cantilever effect from a transverse Kirschner wire drilled into the opposite zygoma as has been described by Brown and his associates (4).

Intracranial operations are usually performed to prevent infection and to remove intracranial hematomas and pulpified brain. The uncertainty of location and extent of fractures and the difficulty of determining the presence of dural lacerations have led to conservatism, which is not always safe. Such an attitude is usually based upon the erroneous assumption that basilar tears are inaccessible or that early spontaneous closure of a cerebrospinal fluid fistula eliminates future risk of intracranial infection. Cerebral contusion, simple concussion, and linear fractures of the anterior wall of the frontal sinus require no operative treatment. It should be noted, however, that Teachenor advocated operation through a medial orbital approach in every patient with a linear fracture of the frontal sinus, even if there is no cerebrospinal fluid leak. The wisdom of this procedure is doubtful in an uncomplicated linear fracture of the anterior wall; a blood clot in the sinus is not apt to cause sinusitis and osteomyelitis. Furthermore, as has been pointed out by

Calvert and Cairns, the exposure afforded by this operation does not permit visualization, or repair of a dural laceration over the cribriform plate.

Fractures of the posterior wall of the frontal sinus present a more difficult and potentially more dangerous situation than fractures of the anterior wall because of the possibility of dural lacerations. Recently we have come to explore virtually all fractures of the posterior wall of the frontal sinus and have found dural tears when their existence was not suggested by clinical or x-ray examination.

When the outer wall of the frontal sinus is depressed, the fragments of bone are removed. Enough bone is removed to permit complete exenteration of the mucous membrane and exploration of the posterior wall for fractures. Care should be taken to preserve the supraorbital ridge unless it is extensively fragmented because reconstruction of the ridge complicates subsequent cranioplasty.

When there are fractures of both the anterior and posterior frontal sinus walls, all of the indriven bone should be removed. Exposure through a bifrontal coronal flap permits easy access to the basal dura. Unilateral exposure may miss dural lacerations caused by fractures extending into the other side. Dural openings can be enlarged, or separate incisions can be made elsewhere to permit the removal of pulpified frontal lobe. The floor of the anterior fossa is explored by elevation of the frontal lobes. Exposure is facilitated by continuous drainage of cerebrospinal fluid through a catheter in the lumbar subarachnoid space. At the end of the débridement, the dura is closed primarily or with a fascial graft. A closure by free muscle grafts is prone to develop a leak after which intracranial infection occurs.

Coleman states that only in exceptional cases is operation for closure of a dural leak through the ethmoids advisable. In our opinion such a conservative attitude is dangerous, even when cerebrospinal fluid rhinorrhea is slight and of short duration. A patient who was operated upon recently had had repeated bouts of meningitis for 20 years following a head injury which was complicated by a minimal leak of cerebrospinal fluid for 2 days. A circular 1.5 centimeter defect in the dura and cribriform plate, through which an adherent knuckle of brain protruded, was found. Following repair of the defect, the patient has not had an episode of meningitis for 4 years. This represents a late focal aseptic necrosis (osteitis desiccans) of the cribriform plate, caused by stripping away the dura. Cairns, in a detailed report of his extensive experience with this injury, presents convincing evidence that all patients with cerebrospinal fluid rhinorrhea should be operated upon. We agree with his conclusion. Operation is not advocated during the acute period of a severe frontal lobe injury because brain edema may make exposure difficult and the brain injury worse. Operation should be performed immediately only if meningitis supervenes. Both an extradural and an intradural approach have been used to explore the floor of the anterior fossa. We perform a bilateral intradural exploration because it gives better exposure, affords an opportunity to remove pulpified frontal lobe, and subjects the dura to less risk of being torn. Furthermore, only inspection can determine whether or not a fracture passes to the other side.

POSTOPERATIVE CARE

Prevention of meningitis and osteomyelitis should be foremost in the postoperative care of patients with craniofacial injuries. Osteomyelitis of membranous bone in the upper face is rare, but osteomyelitis of the mandible is a common and persistent complication. Lower jaw infections are especially prone to develop in patients who have tracheostomies because the oral cavity may be neglected. Regular and diligent mechanical cleansing with forced irrigation and suction is the best deterent to invasion of compound fractures by oral organisms.

Face dressings are difficult to apply and keep clean on excited or unco-operative patients. Nevertheless, accurate clean dressings are important in assuring primary healing with minimum scar formation. Exposed facial wounds soon develop a crust along the suture line beneath which microabscesses may permanently accentuate suture marks. It may be necessary to change facial dressings several times a day to maintain accuracy, cleanliness, and occlusive effect. The eyes should be inspected regularly for corneal or conjunctival irritation from inturned eyelashes or lint from adjacent dressings. Cold compresses should be continued postoperatively to minimize edema. The application of neosporin® ophthalmic ointment to an inflamed conjunctival sac is also beneficial. Following enucleation, it is important to keep a plastic conformer in the socket to preserve the conjunctival sac for a future prosthesis. The conformer should stay in place for approximately a month, with occasional removal for inspection of the conjunctiva. It is not necessary to remove the conformer every day, particularly during the initial healing period. Local inflammation can be treated with ophthalmic neosporin, and the exposed portion of the conformer cleansed with hydrogen peroxide swabs without removing the entire prosthesis.

Male patients should be shaved every day. The external nares should be gently cleansed with moist cotton applicators. No medication should be used in the nose nor manipulations performed other than gentle removal of surface clots and debris from the skin-lined portion of the nostril after rhinorrhea has ceased. Preoperative antibiotics should be continued in full therapeutic doses immediately after the operation.

The initial tetanus immunization should be repeated in 8 to 10 days if contamination was severe or the wound surface extensive.

SUMMARY

Although the combination of trauma to the upper part of the face and anterior portion of the cranium is relatively frequent, the correct timing and selection of operative procedures for these complicated injuries are often perplexing. After hemorrhage has been controlled and a dependable airway established, considerable judgment must be exercised in deciding which aspects of the injury will require operative correction and the priority or correct timing of these procedures. Errors are frequently caused by several specialists acting independently within rigid anatomic boundaries. We believe that successful management requires all consultants to have a broad understanding of the reaction to injury of both facial and craniocerebral tissues.

The indications for operative intervention have been discussed in detail and the correct timing of these procedures may be summarized as follows: Restoration of the eyelids and alleviation of rapidly increasing intracranial pressure from an epidural hemorrhage are emergency procedures which must be performed without delay if blindness and death are to be prevented. Other soft tissue wounds can be closed immediately or delayed if the patient's general condition is precarious. If the surgeon is not forced into an emergency operation to decompress the cranium or cover the cornea, he will usually be able to wait 4 or 5 days before other injuries demand operative correction. Rhinorrhea, fractures overlying dural tears, and restoration of the inner canthus and nasal armature require correction at about 4 to 6 days after injury for optimal results. Midface and upper jaw fractures may be delayed a few days longer, but as a rule these fractures should be reduced within 10 days. Reduction of lower jaw fractures may be postponed as long as necessary. Intracranial hematomas should be considered on an individual basis, as they may develop rapidly and require early evacuation, or develop quite slowly and not be suspected for several weeks.

Important points in surgical technique and references to detailed descriptions of operative management have been presented.

We believe that the most important principles are internal fixation of facial fractures and an aggressive operative approach to all fractures overlying lacerations of the dura or complicated by the loss of cerebrospinal fluid.

REFERENCES

1. Cairns, H. Injuries of the frontal and ethmoidal sinuses with special reference to cerebrospinal rhinorrhea and aeroceles. J. Lar. Otol., Lond., 1937, 52: 589.
2. Calvert, C. A., and Cairns, H. Injuries of the frontal and ethmoidal sinuses. Proc. R. Soc. M., Lond., 1942, 35: 805.
3. Coleman, C. C. Fracture of the skull involving the paranasal sinus and mastoids. J. Am. M. Ass., 1937, 109: 1613.
4. McDowell, F., Brown, J. B., and Fryer, M. P. Surgery of the Face, Mouth, and Jaws. St. Louis: The C. V. Mosby Co., 1954.
5. Teachenor, F. R. Intracranial complications of fracture of the skull involving frontal sinus. J. Am. M. Ass., 1927, 88: 987.

FASCIA LATA, CUTIS, AND TANTALUM GRAFTS IN REPAIR OF MASSIVE ABDOMINAL INCISIONAL HERNIAS

CLAUD C. BURTON, M.D., F.A.C.S., Lake City, Florida

POSTOPERATIVE ventral herniations are preceded by wound dehiscence of variable extent. They usually occur in the early postoperative period. The most critical time is during the awakening postanesthetic phase or while the patient is under observation in the recovery room. It is not uncommon for an incipient hernial separation to develop then and not become manifest until several weeks or months after the operation. In general, the incidence of incisional hernia is about 5 per cent in clean wounds and 10 per cent in contaminated wounds.

Many collateral etiologic factors may contrive to produce complete or incomplete, early or late, dehiscence of the wound. In this category, wound infections have long played an important role, and currently there has been a revival of interest in wound complications, particularly those attributable to staphylococcal infections. Wound suppuration is the second most frequent source of dehiscence of the wound. The importance of the nutritional status of the patient is gaining increasing recognition, and the response of the patient to surgical stress with its accompanying endocrinologic aspects is also becoming better identified. The age of the patient, especially those in the older group, is being better oriented in respect to the composite clinical picture. Falling in a comparable etiologic area are chronic anemia, marked weight loss, hypoproteinemia, vitamin deficiency, and decline in positive nitrogen balance.

Occult wound separation may escape detection for some time after operation, often deluding the patient to think that a recent coughing paroxysm or straining at lifting or at stool was the primary rather than the precipitating cause of the sudden weakness.

Preponderantly, the herniation is a mute reminder of inordinate stress on the incision that transpired in the early postoperative period. This conception is by far the most potent and constant factor contributing to the development of incisional hernias. Illustrative of this fact, I can recall having observed, on at least 3 occasions, the first row of silk sutures used in Cooper's ligament repair either break or tear out from inordinate straining during too light anesthesia. In each instance, fascia lata sutures were substituted. The same stress factors were again permitted to obtain, demonstrating a solidly anchored wall.

It is generally conceded that suctioning of the trachea before the patient is moved from the operating table, which is often repeated in the recovery room, reduces the incidence of aspiration with coincidental atelectasis and pneumonia but concomitantly produces maximal straining on the freshly sutured abdominal wound. Moderate suctioning of the trachea would therefore seem advisable except in those patients predisposed to pulmonary complications.

After the initial wedging of omentum or a loop of bowel between the separated wound edges, its progress is often augmented by coughing paroxysms or straining. A repetition of this process may culminate within a matter of weeks in a recognizable and increasingly larger ventral herniation. There is convincing evidence that the development of an incisional hernia is chiefly an indictment of either the security of closure or contamination of the abdominal wound. Prophylactically, it is of utmost importance that the surgeon exercise meticulous care and aseptic technique in the primary suture of the wound.

Debilitated patients who are subjected to major surgery often have impaired nutritional reserve, hypoproteinemia, and vitamin deficiency which may inhibit the reparative forces. There is a higher index of wound separation in patients in this category. The extent of the period of maximal nutritional imbalance is not accurately measurable. The consensus is that its height is reached in the first few weeks of the patient's convalescence.

Therefore, from clinical observation, etiologic considerations, and statistical studies, wound separation may be divided into three chronologic periods: (1) the postanesthetic, (2) wound suppuration, and (3) nutritional imbalance. Practically, there are instances in which some periods may coexist or overlap. The nutritional imbalance of the patient may antedate the operation and continue for several weeks postoperatively.

CLASSIFICATION OF INCISIONAL HERNIAS

Defects of the abdominal wall are divided into three types: (1) Those hernias in which the edges of the parietal wall can be approximated or imbricated without undue tension. Ordinarily they are not discernible to the patient. These hernias are incipient, often asymptomatic, and present no problem in their repair. (2) Those which preclude edge to edge contact but with only 2 to 3 centimeters of separation. A relief incision in the anterior rectus sheath on either side may be adequate to permit approximation of the edges. Another alternative method of repair of this type is the interlacing of autogenous fascial sutures so as to obtain a lattice-like bridging of the interparietal defect. (3) Those hernias in which the ring or separation in the wall is so large that no method of suture can adequately close the opening. In the massive hernias intermural separation measures 8 centimeters or more in width and is usually associated with tissue deficiency and often with appreciable concomitant collateral weakness of the adjacent walls. These hernias comprise about 15 per cent of all incisional hernias and it is this type of herniation which challenges the ingenuity and skill of the surgeon in attaining a solid wall. It is this type of hernia which is to be discussed as well as our reparative experience with fascia lata, cutis, and tantalum grafts.

Ordinarily, repairs of ventral hernias are elective procedures. The hernia, while not painful, steadily progresses in size and often is disabling, especially for those engaged in laborious occupations. The distortion of the abdominal wall is the main source of concern to the patient and his family. Reduction of these hernias is usually a simple maneuver, and not infrequently they spontaneously reduce in recumbency. Of significance is the fact that these hernias cannot be satisfactorily maintained in reduction by various ingenious belts or appliances while the patient is ambulant. This characteristic is attributed to: (1) parahiatal muscle weakness, (2) the absence of sphincteric function of its circumferential boundary, and (3) the fact that the exit through the abdominal wall is direct rather than oblique. The only alternative treatment for this annoying disfigurement and disablement is adequate anatomic repair of the hernial defect.

The successful treatment of hernias of this magnitude presents a continuing reparative and often controversial problem to the surgeon. Attesting to this dilemma are the various plastic procedures that have been employed, none of which has become standardized in the sense of attaining predominant and sustained recognition. Despite this lack of universal agreement on operative procedures the tendency is toward greater uniformity of technique, and consequently better reparative results are being attained.

A large or massive incisional hernia may be defined as one in which the mural defect measures a hand's breadth or more. The interparietal separation is frequently accompanied by attenuation of the intervening scar tissue and marginal spreading from associated weakness of the adjacent walls producing parabolic enlargement of the hernia. It is not uncommon for the latter to progress

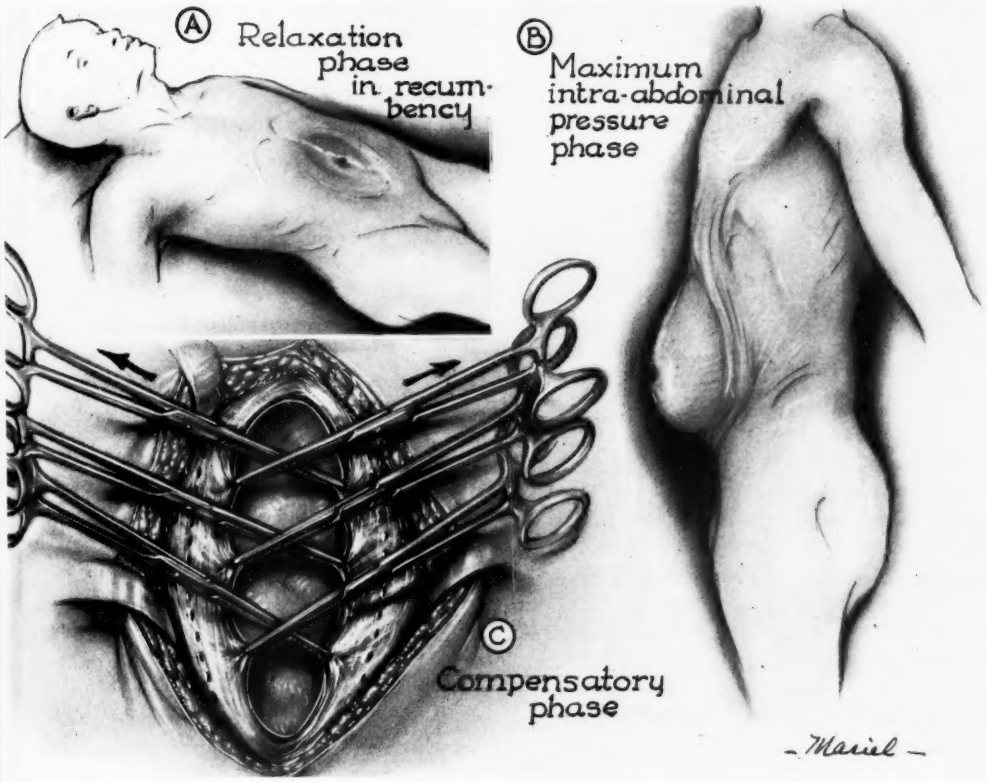


FIG. 1.

to the extent of obscuring the periphery of the defect. The mural defect and collateral weakness jointly may reach such proportions that to restore security and continuity of the wall will necessitate replacement of the defect with an inlay graft.

Measurements of the cuboidal dimensions of a massive ventral hernia are foremost in its treatment, but of almost comparable importance to this information are the availability and strength of the wall adjacent to it. Other contributing factors are: (1) the quality of the parietal strata and whether the patient is of the sthenic or asthenic type, (2) the anatomic location of the hernia and to what extent the adjacent parietal structures lend themselves to adequate mobilization, and (3) the nearness of the defect to the costal arch, symphysis pubis, or iliac crest. All of these structural and relational anatomic variants play a significant role in the assessment of the hernia and its successful reparability.

EXAMINATION OF THE ABDOMINAL WALL

On reviewing the literature, there has been a propensity of the surgeon to employ comparative descriptive terms in lieu of accurately recorded measurements of the parietal defect. This point is stressed because the former method was not only inaccurate and confusing, leading to variable conclusions, but was conducive to a lackadaisical examination. Photographs of the hernia are not a substitute but are adjunctive to the clinical examination, and they may be deceptive unless the exposures are taken in different positions. In order to pre-

sent a more exact dimensional, functional, and anatomic picture of the herniation, it is proposed that the measurements of the parietal defect be recorded in three successive phases, anatomic, physiologic and surgical.

Relaxed or recumbent phase (*Fig. 1A*). The earliest and simplest diagnostic maneuver to be used is to have the patient assume the recumbent position thereby lessening the intra-abdominal pressure, producing a negative reading which generally effects a spontaneous reduction of the hernia. In the event that the hernia is incarcerated and perhaps has dissected into a loculated intraparietal pocket, only a partial reduction may obtain. In most incisional hernias the outline of the defect is easily seen in this position, except when the margins of the adjacent walls are quite attenuated. The length and width of the defect are recorded if it is rectangular in outline, and the diameter of the hiatus, if it is circular. With the patient supine, the abdominal wall is more flaccid, which gives the examiner the opportunity to appraise by palpation the strength and density of the rarefied connective tissue stratum bridging the defect. Not infrequently, peristaltic waves may be seen beneath a thin parietal wall. Similarly, from palpation of the defect, additional knowledge may be derived concerning the integrity, elasticity, and muscle tone of the adjacent parietal wall. The systematic collection of these informational data constitutes the initial step in the composite evaluation of a ventral hernia preparatory to operative intervention.

Intra-abdominal tension phase (*Fig. 1B*). The maximal dimensions of the mural defect and resultant distortional sequelae are strikingly manifested by the herniation at the height of intra-abdominal pressure. It, of course, follows that if there is considerable concomitant weakness and thinning of the parietal wall surrounding the hiatus, the displacement of its margins is wider and the protrusional mass larger. A patient with a large ventral hernia is continually cognizant of the mural distortion so well demonstrated in the erect position. Clinically and subjectively, it is the most dramatic, photogenic, and convincing phase in the evaluation of the herniation. It is the phase commonly meant when the patient or his physician refers to the size of the hernia. However, it does not necessarily follow and, in some instances, is misleading to assume that the larger the protrusion and concomitantly the greater the defect in the abdominal wall, the more difficult the hernia is to repair; but in general this is true.

Compensatory or operative phase (*Fig. 1C*). In the progress of the examination, the cumulative data should give impetus to continue the search for further helpful information. At operation, after the hernia has been mobilized and reduced, the attenuated hiatal margins which consist mostly of scar tissue are trimmed away. This procedure may require removal of a thinned out cicatricial band perhaps 2 to 3 centimeters in width. The newly delineated margins should approach normalcy and constitute the unyielding anatomic boundaries of the defect to which the implant is anchored.

By definition, massive ventral hernia implies that in order to re-establish continuity of the parietal wall an inlay graft will be necessary. The next step is to determine the minimal dimensional requirements of the graft needed to bridge the defect. Since there is generally considerable relaxation of the abdominal wall associated with the expanding herniation, it is frequently possible to use the relaxed wall to effect a compensatory reduction in the dimensions of the defect.

During operation, the surgical appraisal of the size of the hernial defect is determined by applying Kocher clamps to either side of the anatomic hiatal margins, so that with moderate traction on the forceps toward the middle of the defect the wound edges may be drawn medialward 2 to 3 centimeters on either side (Fig. 1C). This maneuver may result in a total reduction of 4 to 5 centimeters in the size of the graft needed for the

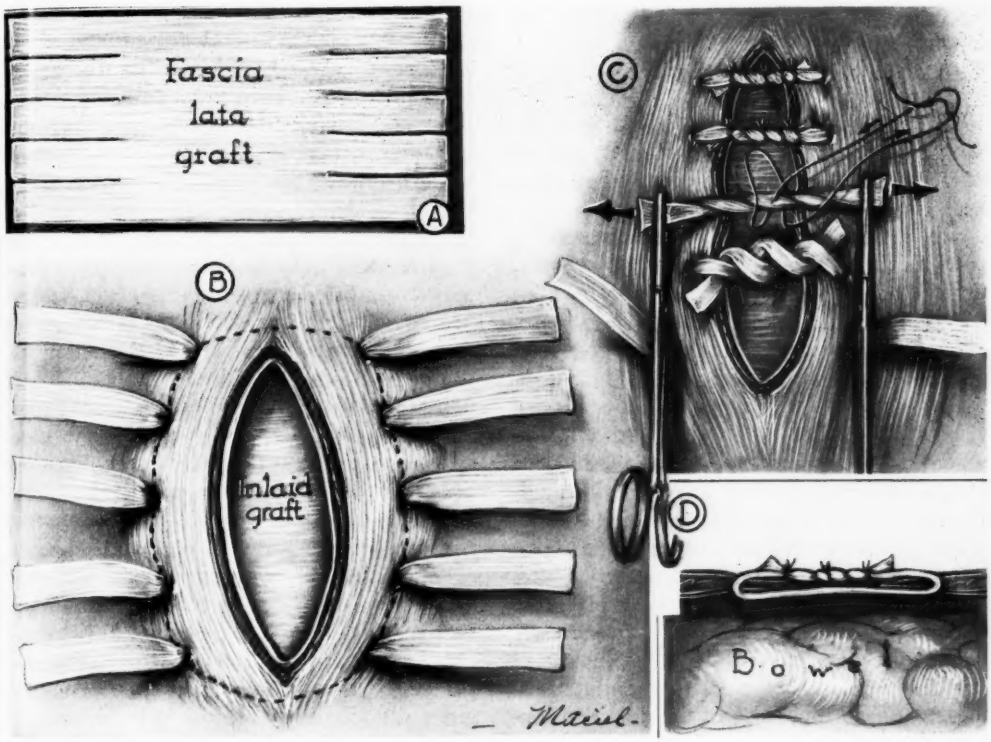


FIG. 2.

repair. It also affords the opportunity to measure the absolute size of the defect that must be replaced by the graft in order to restore the continuity of the wall and simultaneously to overcome any acquired laxity of the adjacent walls.

From clinical observations which have been corroborated by established mechanical principles, the more deeply the graft is placed in relation to the abdominal wall strata the earlier its shunting action in response to intra-abdominal pressure and concomitantly greater the stability of the repaired wall. Consequently, deeply placed inlay grafts at the peritoneal level possess advantages over sliding or onlay grafts. Relaxing incisions in the rectus sheath to permit its shifting medialward as a sliding graft may subsequently serve as a gap and a potential source of another secondary mural weakness. Because of the possibility of this remote complication which has occurred once in our experience in the repair of inguinal hernias, it is preferable to avoid this maneuver.

FINGERED FASCIA LATA GRAFT REPAIR

Our experience in the surgical management of massive ventral hernias, which incidentally are often recurrent one or more times, has been limited to fascia lata, cutis, and tantalum mesh grafts. They have been employed exclusively as inlay grafts. In reviewing the comparative technique used in this series, the results obtained with autogenous transplants have been consistently better, insofar as attaining an unyielding wall, than those with the heterografts. Gallie, Singleton and Stehouwer, Hamilton, and Austin and Damstra have reported

favorably and convincingly of the efficacy of fascia lata grafts. Loewe, Uihlein, Ali, and Rutter have advocated the use of cutis grafts with comparable enthusiasm.

In the removal of the fascia lata graft, a long incision, curved slightly anteriorly, is made over the lateral aspect of the thigh extending from the greater trochanter downward to within a hand's breadth of the knee. This incision gives exposure to practically the entire fascia lata sheet. A rectangular graft, 8 to 9 centimeters wide and 12 to 14 centimeters long is excised. No attempt is made to close the fascial defect which ensues. The inner and outer transverse layers of the margins of the fascia regenerate and bridge the gap but the absence of regeneration of the longitudinal layer of fascia lata has remained unexplained. Rarely has any objective or subjective impairment in the function of the donor limb been observed.

Before placement of the graft, its ends are cut into 5 or 6 parallel fingers (Fig. 2A). It is important to leave an intervening solid sheet equal to the width of the defect in the wall. The processed graft now looks like a many tailed abdominal binder. In its fixation, the fingers of the graft are threaded successively through a large eyed needle. The latter, in turn, is passed through the entire thickness of the abdominal wall except the skin, about 2 centimeters from its edges (Fig. 2B). The fingers are tied anteriorly and transfixed with 3 silk sutures (Fig. 2C). During the placement of these sutures, the fascial fingers are held taut with a hemostat on either end. By following this technique in the fixation of the graft, there is created in effect a double thickness fascial wall; one, in the form of a deeply placed strong fascial sheet bridging the interparietal gap; the other, anteriorly consisting of fascial cords producing a ladder-like appearance (Fig. 2D). This technique of providing dual tensile strength by architectural modification of the implant further augments the stability of the parietal wall by preventing any eversion of the junctional margins. Ordinarily, there is some serous drainage of the wound for several days postoperatively, which is attributable to the extensive dissection necessary in mobilizing the wall. Rarely does the drainage become purulent.

CUTIS GRAFTS

Cutis grafts have been employed in the same manner as fascia lata grafts except that they are sutured under more tension, which promotes metaplasia. This conception of increased tautness is in contradistinction to the generally accepted rules for hernia repair. Cutis grafts have shown a more rapid metamorphosis and an equally stable wall as the fascial implant. Occasionally, the previously raised split skin graft preparatory to excision of the dermal transplant may not take primarily when replaced, making regrafting of the donor site necessary. However, there can be no herniation or weakness of the donor site. Another rare complication is cyst formation which was reported by Rutter as occurring as late as 7 years after a cutis graft repair. There is, therefore, increased morbidity when autografts are used but it is balanced by greater assurance of a smooth, uniformly taut, and viable wall.

TANTALUM GAUZE GRAFTS

The properties of tensile strength, pliability, and aseptic tolerance of tantalum have been amply demonstrated by experimentation and subsequent clinical application. The objections which have been raised to the use of tantalum are: (a) Fatigue fractures of the tantalum strands occur, and ultimately weakness or miliary herniations at the fragmentation sites. (b) Tantalum is less pliable than autografts, and repairs with it are not as comfortable. (c) The contour of the repaired wall may become irregular and is prone to assume a corrugated appearance. (d) Another potential deterrent to the employment of tantalum is that, if for any reason it becomes necessary to remove it, the entire grafted wall must be

excised. This would mean sacrificing some of the initial normal marginal wall so that the secondary repair would present a more formidable operative procedure than the original herniation. In our limited experience with tantalum inlay grafts, we have encountered some of these complications. This fact has dampened our enthusiasm for tantalum although the placement of these grafts requires less time and there is no donor site complication with which to contend.

STATISTICAL MATERIAL

In our series of 108 incisional hernias, 30 fell in the category of large or massive hernias.

Our greatest experience has been with the fascia lata fingered graft of Gallie with a total of 15. There were 2 instances in this group in which the weakness of the wall was of such proportions that 2 fingered grafts, 1 from either thigh, were placed parallel to each other in order to bridge the defect effectively. Wound complications in the autofascial group were inordinately high. There was serous drainage with varying degrees of infection lasting from 1 to several weeks in 9 instances. In 1 patient the drainage persisted for a year until silk sutures and some fragments of the graft were finally extruded. This was the only case in which the viability of the graft was imperiled. Despite these complications, a follow-up study of 1 year or longer after repairs with fascia lata grafts is so encouraging that it lessens somewhat the onus of the high morbidity in this group.

Since there is greater latitude in obtaining the cutis graft, its inherent capacity for undergoing metaplasia, the fact that it is denser than fascia, its multidirectional tensile strength, and the function of the donor site is not compromised, this type of transplant was used in 4 cases. In 2 instances there was drainage of serum from the hernial wound for several days but there arose another disquieting complication. The replaced split graft of the donor site failed to take primarily in 2 instances and required regrafting. On the positive side of this technique the repaired wall was comparable in strength to, if not more resistant than, the wall repaired with fascia lata. The choice between dermal and autofascial grafts rests largely on one's preference and experience.

Tantalum mesh implants were employed in 11 massive hernias. There were fewer wound complications in this group, occurring in 3 instances. Ten of the 11 patients were followed up for 1 year or longer. In 1 patient the mesh became fragmented in several places, producing ridgelike elevations adjacent to the fractured strands. At reoperation in 1 case it was found that the mesh was so impregnated with ingrowth of connective tissue that the tantalum sheet could not be peeled out. There was no alternative but to excise the wall with the graft. A taut wall resulted in the other cases in which repair was with tantalum.

DISCUSSION

In contrast to most reports on incisional hernias, emphasis has been placed not so much upon the size of the mural defect but more on the anatomic location and the quality or resiliency of the adjacent parietal strata. Once there is an initial dehiscence of the wall, continuing expansion of the herniation is augmented by intermittent variations in intra-abdominal pressure, which for the most part are unavoidable and uncontrollable.

The criteria which have been proposed for the appraisal of incisional hernias assume increased significance if substitutional therapy is under consideration. In general, the nearer the herniation to fixed anatomic structures the more difficult it is to repair. This is due to the decreasing elastic potential of the adjacent musculofascial wall. Similarly, the more remote the herniation from bony structures, the greater the possibility of a resilient parietal wall on either side of the defect which may act as an augmenting compensatory factor in the repair.

It is our contention that the 3 successive diagnostic steps which have been described and illustrated create a tridimensional perception of the weakness and are helpful in imparting definitive knowledge for the evaluation of the composite herniation. Moreover, information accruing from these positional maneuvers has led to the choosing of more selective techniques in the surgical management of the hernia. To attain the best results, the surgeon must be resourceful, imaginative, and a strong visualist in performing the architectural repair of difficult incisional hernias.

In the operative series presented, the end results have been better with the autografts of fascia lata and cutis. The perfect regularity of autogenous graft survival despite wound complications is further evidence of the superiority of the autogenous fingered graft repairs. However, we are intensifying our efforts to reduce the incidence of drainage occurring postoperatively. When dermal grafts are employed there should be immobilization of the donor limb to promote primary take of the split graft and thus obviate the necessity for regrafting of the donor site. Cutis is more vascular and undergoes metamorphosis more rapidly than fascia. Tantalum mesh has not been as successful as autogenous grafts, in our hands, and consequently we shall be less prone to use heterografts.

There are certain inherent factors of the implant and its placement which should be emphasized: (1) security of its anchorage, (2) adequate tensile strength, (3) tolerance of the graft by the host, and (4) maintenance of physiologic tautness of the graft. There is integral survival of fascial implants, but only dermal grafts are capable of undergoing fibrous metaplasia. The fingered fascia lata and cutis grafts in contrast to the free patch implants are more strongly anchored and provide additive strength of the repaired wall. The former exact the maximum physiologic and anatomic efficiency in restoring the wall to normalcy.

SUMMARY AND CONCLUSIONS

1. The problem of the massive ventral hernia is a composite one: prophylactic, diagnostic, anatomic, and physiologic in scope.

2. The reduction of the incidence of ventral herniations is dependent upon restoration of the abdominal wall at the operative site to as near anatomic normalcy as possible and upon maintenance of this contact relationship until healing is complete.

3. Diagnostic criteria have been described and illustrated to aid in the evaluation of the hernia.

4. The selection of the appropriate type of repair rests upon the size and characteristics of the mural defect as well as the ingenuity, experience, and imagination of the surgeon.

5. The statistical study of this series embraces three different types of grafts: fingered fascia lata, cutis, and tantalum mesh.

6. Autogenous grafts gave the best results but they also had the highest number of wound complications.

REFERENCES

1. Ali, Munawar. Cutis strip and patch repair of large inguinal hernias. N. England J. M., 1954, 251: 932–934.
2. Austin, Robert C., and Damstra, Eugene F. Fascia lata repair of massive ventral hernias. Am. J. Surg., 1951, 82: 466–473.
3. Gallie, William Edward. Closing very large hernial openings. Ann. Surg., 1932, 96: 551–554.
4. Hamilton, Joseph E. Free mattressed fascia lata patches in the repair of large abdominal incisional hernias. Am. Surgeon, 1956, 22: 217–226.
5. Loewe, O. Ueber Hautimplantationen an Stelleder freien Faszienplastik. Münch. med. Wschr., 1913, 40: 1320.
6. Rutter, A. G. Cyst formation 7 years after a cutis graft repair of hernia. Brit. M. J., 1955, 1: 951–952.
7. Singleton, A. O., and Stehouwer, O. W. The fascia-patch transplant in the repair of hernia. Surg. Gyn. Obst., 1945, 80: 243–251.
8. Uihlein, Alfred, Jr. Use of cutis graft in plastic operations. Arch. Surg., 1939, 38: 118–130.

THE MANAGEMENT OF ABDOMINAL INJURIES

HU C. MYERS, M.D., F.A.C.S., Philippi, West Virginia

LIKE OTHER FORMS OF TRAUMA, abdominal injuries are frequently exasperating. They occur at the most inopportune times; the patients are often covered with grime and dirt and some may be unco-operative from the effects of alcohol; the surgeon is often confronted with a variety of injuries of several people at the same time. In spite of these unfavorable aspects, trauma to the abdomen presents a challenge which is unique because of the wide variety and the extent of the pathologic conditions involved. The problems of diagnosis and treatment range from the very simple to the extremely complex and call upon all the skill that a surgeon has at his command.

Abdominal injuries comprise only a small percentage of the total number of accidents. They are very important, however, since many of them end fatally unless prompt and proper treatment is carried out. These injuries may occur anywhere. An increasing number are the result of traffic accidents; any driver or passenger may suddenly find himself in a strange hospital and under the care of a strange surgeon. Probably less than 50 per cent of such patients will be taken to large hospitals where they will be cared for presumably by a well organized trauma team. The others will be transported to hospitals of from 25 to 199 beds, many of which cannot have the trained traumatic surgeons or the auxiliary services and equipment found in larger centers. In spite of this fact, if there is an adequately trained and diligent medical staff the principles and methods which have led to a markedly lower mortality in the past 2 decades can be applied successfully.

The experiences of the staff of a 102 bed hospital in Philippi, West Virginia, were found to portray graphically these changes in results in the treatment of abdominal trauma, as the new developments made it possible to control infection and replace blood rapidly. The records of all cases of proved injury to one or more of the intra-abdominal organs, and major hemorrhage into the retroperitoneal space produced by external violence during a 25 year period were used as a background for this study.

Of 54,254 admissions from January 1934 through December 1958, approximately 5.1 per cent or 2,767 were cases of trauma which were considered serious enough for admission to the hospital. About 3 times that many injured patients were treated as outpatients only. Of the hospitalized patients 72 or 2.6 per cent had abdominal injuries. The involved organs and the frequency of injury in each were: kidney 17 cases, ileum 11, urethra 10, colon 9, retroperitoneal space 9, jejunum 8, spleen 8, bladder 6, liver 6, stomach 3, duodenum 3, pancreas 3, rectum 2, ureter 1, and diaphragm 1; 79 per cent of the cases involved trauma to a single abdominal organ, and 21 per cent two or more organs; 68 per cent involved other parts of the body.

Nineteen of the injuries were gunshot wounds, 18 were crushing coal mine injuries, 14 were automobile accidents, 10 were falls, 7 were blows, 3 were stab wounds, and 1 was caused by a dynamite cap explosion.

The over-all mortality rate was 22.2 per cent, but there was a steadily decreasing mortality in the first half of this period as shown by the graph in Figure 1. This change came during the period when chemotherapy, antibiotic therapy, more efficient blood replacement methods, better anesthesia, and other important developments in medicine were being added to the sur-

From the Departments of Surgery, Myers Clinic and Broaddus Hospital, Philippi, West Virginia.

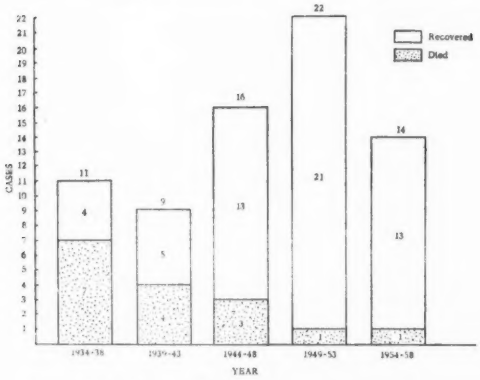


FIG. 1. Number of abdominal injuries in each 5 year period divided into survivals and deaths.

geon's armamentarium. The improvement in recovery rate was credited to these factors, though cumulative experience undoubtedly also played a part. The graph in Figure 2 shows the combined mortality when the 25 year period is divided into two equal parts. The first period in this grouping is the one during which modern methods of diagnosis and treatment were being developed. The second period is the one in which these aids were available to all patients. The mortality rate for the first half of the 25 year period was 52 per cent and for the second half 4.4 per cent. The two groups of cases were studied in detail to determine whether the decrease in mortality rate might have been the result of other factors.

A possible decrease in severity of the trauma and a change in type of accident were considered as the two most likely possibilities. After an analysis of the cases from these standpoints it was concluded that no two of these accidents were identical, and the effects of no two of them were the same. Nevertheless, it was found possible to compare factors roughly.

There was a decrease in only two types of accidents during the second period. There was one less stab wound and no injury caused by a dynamite cap explosion; all of the others remained the same or were increased, although not percentagewise. The crushing mine injuries remained the same in type and, from a study of the records, appeared to be about the same in severity.

When the anatomic part which was injured was considered it was found that the chief differences in the two periods were an increase during the second period of wounds of the stomach, duodenum, spleen, pancreas, kidney, bladder, and urethra; and a decrease in injuries to the jejunum, ileum, liver, and retroperitoneal space. The decrease in hemorrhage into the retroperitoneal space was probably not a real decrease because this diagnosis was made most frequently at autopsy. Since there was a decrease in deaths in the second period, there was likewise a decrease in autopsies.

It would seem, then, that neither the type of accident nor the extent of the trauma was a significant factor in the reduction in mortality in the second period. Thus the improvement must have been the result of new methods and aids which were available to the surgeons and, to some extent, the result also of accrued experience.

DISCUSSION OF DEATHS

There were 16 deaths: 8 were from hemorrhagic shock; 6 were caused by various types of infection; 1 was from mesenteric thrombosis; and 1 from pancreatic necrosis. The autopsy rate was 75 per cent.

An attempt was made to classify the deaths into groups which would show general causes and, by implication, the mode of prevention of such deaths. A study of the records indicated that they might logically be classified into 5 general groups: (1) deaths which were apparently not preventable, (2) uncontrolled infections, (3) insufficient replacement of blood, (4) incomplete operations, and (5) errors in diagnosis.

NONPREVENTABLE DEATHS

Three cases were considered as belonging in the first group as nonpreventable deaths.

CASE 1. This patient died in 1938 of mesenteric thrombosis following a crushing mine injury which produced massive hemorrhage into the retroperitoneal space. Autopsy did not reveal any injury to a major vessel.

In this case it is possible that exploration of the retroperitoneal space might have revealed the source of hemorrhage and that it might have been controlled; this would have prevented the local stasis which apparently initiated the thrombosis.

CASE 2. This patient was a coal miner who was injured in a slate fall in 1950. He had multiple fractures, massive retroperitoneal hemorrhage, and hemorrhage into various abdominal and thoracic organs. His initial blood pressure was 60/30. In spite of 2,000 milliliters of blood and other supportive measures he died in shock 2½ hours after admission.

CASE 3. This patient had a gunshot wound of the left buttock and pelvis, which had been inflicted at close range. He was in profound shock with a blood pressure of 30/0. He was given 3,000 milliliters of whole citrated blood and a proximal colostomy was performed. The wound was treated by debridement, and posterior drainage was instituted. In spite of large doses of antibiotics a septic type of temperature developed, as well as marked induration in the gluteal region, and finally a shock-like syndrome. He expired 6 days following the injury.

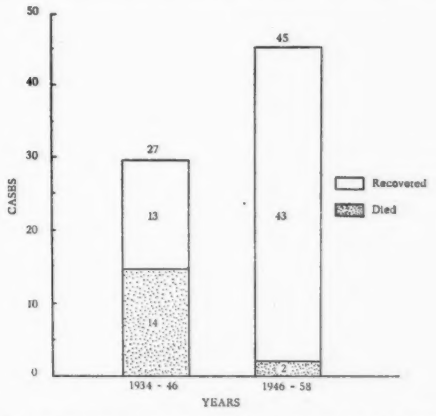


FIG. 2. Number of abdominal injuries divided into two 12½ year periods showing survivals and deaths.

INSUFFICIENT REPLACEMENT OF BLOOD

Six patients apparently died of hemorrhagic shock.

CASES 6, 7, 8, 9, 10. Five of these patients had multiple injuries produced by crushing forces. The major result in each instance was retroperitoneal hemorrhage of marked degree. The extent of blood loss in each was not recognized until an autopsy was performed. The patients lived from 2 to 5 hours after admission. The dates of treatment were 1936, 1938, 1940, 1942, and 1944. Notes appear on some of the records indicating that donors were being sought or that blood was being typed and cross matched, but the patients died before blood was available.

The prompt estimation of concealed blood loss and access to stored blood would have permitted adequate blood replacement and should have saved those not already victims of irreversible shock.

CASE 11. The sixth patient in this group had a severe gunshot wound with multiple perforations of the small intestine and sigmoid. This injury occurred in 1935. Closure of the small intestine and exteriorization of the sigmoid were performed, and the patient received 400 milliliters of blood. He died 9½ hours later presumably of hemorrhagic shock.

An adequate amount of blood apparently would have saved this patient's life. Whether he would have survived the inevitable infection which would follow, since no effective treatment for such infection was then available, cannot be determined.

INCOMPLETE EXPLORATION OR OPERATION

Two patients were placed in the group having incomplete exploration or operation.

CASE 12. This obese white coal miner of 49 years received blunt trauma to the abdomen in 1934, which resulted in a perforation of the posterior wall of the descending colon, following which a large abscess developed in the retroperitoneal space. He was treated expectantly at another hospital, then admitted here 14 days after his accident. Exploratory celiotomy was performed twice. At the first operation incomplete exposure resulted in failure to find the pathologic condition. At the second operation the patient's general condition had deteriorated to such an extent that exploration had to be abandoned. The patient lived 5 days after his last operation.

With facilities which are now available, a thorough exploration, including mobilization of the descending colon, would have been possible and would have given the patient a good chance to recover.

CASE 13. This patient, admitted in 1940, had suffered multiple contused lacerations of the right

lobe of the liver. The liver was packed with gelatin foam sponges and gauze, and he was given 1,500 milliliters of blood. Following removal of the last of the packing on the tenth day there was a small amount of bleeding. This increased gradually for 24 hours, then became suddenly profuse and exanguinating in spite of the administration of an additional 3,500 milliliters of blood.

With an adequate amount of stored blood available this patient would now be treated initially by resection of the severely traumatized portion of the liver.

ERRORS IN DIAGNOSIS

In 3 cases there were multiple injuries and in each instance the one which was responsible for death was undetected until an autopsy revealed its presence.

CASE 14. This patient was injured in a rock fall in a coal mine. He was admitted 2 hours later in profound shock. There were multiple fractures of the pelvis, hematuria, and several lacerations and contusions. The abdomen was tender and rigid. It was thought that this was caused by the fractures of the pelvis. Cystograms revealed no extravasation of the contrast medium. He was treated by blood transfusions, reduction of his fractures, debridement and suturing of his wounds, a pelvis sling, and nasogastric suction. He improved for about 24 hours and then a shock-like syndrome developed which did not respond to transfusions and supportive measures. He expired 40 hours after admission. An autopsy revealed a complete transection of the ileum.

CASE 15. This patient, treated in 1945, was a white male of 49 years with multiple gunshot wounds of the neck, chest, abdomen, and extremities. Wounds in the jejunum were closed by purse-string sutures. A wound in the sigmoid was treated by exteriorization. He was given sodium sulfadiazine intravenously but a subphrenic abscess developed from which he died. An autopsy revealed a wound of the liver made by a missile which had penetrated the chest and diaphragm. This wound had not been discovered at operation.

CASE 16. This patient was a man of 72 years who, in 1945, was struck in the upper abdomen by a heavy board. Examination demonstrated tenderness and rigidity especially in the right hypochondrium. His blood pressure was 60/40. He was given 500 milliliters of blood plasma, and exploratory celiotomy was performed. A partial avulsion of the gallbladder with laceration of the liver was found. There was hemorrhage into the greater and lesser omentums. The gallbladder was drained and the liver was sutured. The patient was given 2,500 milliliters of citrated blood during the next 4 days. Nasogastric suction was used and sodium sulfadiazine was given intravenously. After 36 hours he became irrational, then a temperature of 104.2 degrees F., hypotension, cyanosis, and anuria developed. He expired 5½ days after admission. An autopsy revealed extensive pancreatic necrosis.

DISCUSSION

These cases illustrate many important aspects of the problems of abdominal trauma. They demonstrate the necessity and the advantage of adequate staff and hospital preparation for emergencies. In our experience the most important part of this preparation has proved to be the maintenance of an efficient blood bank. One unit of emergency blood is stored close to the emergency room and is always immediately available; an adequate supply of additional stored blood is kept in reserve to meet the requirements of unusual situations. Fifty per cent of the deaths in this series of cases were from hemorrhagic shock. It is significant to note that all but 1 of these fatalities occurred before the establishment of a blood bank, and that the improvement in our recovery rate closely paralleled improvements in our blood replacement methods. The availability of blood has contributed also to the use of deliberate operative procedures and has permitted thorough explorations of the abdominal cavity.

A high index of suspicion played an important role in the reduction of mortality. All blows to the abdomen, lower thorax and pelvis, as well as all falls, all crushing injuries, and all penetrating wounds of the trunk or upper parts of the thighs were considered as having produced trauma to an abdominal organ until proved otherwise. The patient was examined for tenderness and rigidity and if none was found he was re-examined at frequent intervals for several hours. A roentgenogram of the abdomen with the patient in the upright or left lateral decubitus position was made and was sometimes of help especially if there was a ruptured viscus. However, not too much time was spent on diagnostic pro-

cedures if significant tenderness or rigidity of the abdominal wall was present.

Prompt exploratory celiotomy proved life-saving in many cases. The steps in such procedures which were considered essential are: (1) emptying of the stomach before the induction of anesthesia, (2) use of general anesthesia in most instances (local was never used), (3) making of a long paramedian or transverse incision, (4) a thorough search for multiple injuries, (5) especial attention to the retroperitoneal structures including the duodenum, vena cava, aorta, bladder, ureters, kidneys, pancreas, rectum, and the posterior surfaces of the cecum, ascending colon, and descending colon.

Before exploration of a retroperitoneal hematoma for possible vena cava injury a large amount of blood was cross matched for rapid replacement, and extra assistants were summoned. Negative explorations were remarkably few, and the patients and the surgeons believed that the negative findings, when present, gave a sufficient amount of peace of mind to justify them.

CONCLUSIONS

1. Abdominal injuries are relatively few but highly lethal if not properly treated.

2. Surgeons now have the tools and methods which, if properly used, will salvage most of these patients.

3. Probably the most important aid to the surgeon is an efficient blood bank which can provide an adequate supply of blood without delay.

4. Frequently the patient has no opportunity to choose his surgeon or hospital, and the surgeon may not be in a position to reject the patient.

Because of these facts, improvement in the management of trauma should be of concern to all surgeons.

EDITORIALS

THE REMARKABLE VISION OF DR. JONES

CHANDLER SMITH, M.D., Cleveland, Ohio

Doctor Jones was a remarkable man. He could see through tissue, and he could see the precise anatomic location of tumor deposits in a patient with cancer. For a patient with cancer of the breast, he could tell at a glance whether the tumor was localized to the breast, whether spread to the axilla had occurred, or whether distant metastases were already established. This ability provided him with the enviable advantage of knowing which method of treatment was suitable for each patient. When the tumor was localized to the breast, he recommended simple mastectomy, when the spread was limited to the axilla, he employed radical mastectomy, and when he saw metastases in the lungs or liver, he suggested palliative measures. The only difficulty was that Doctor Jones could not tell others what he could see.

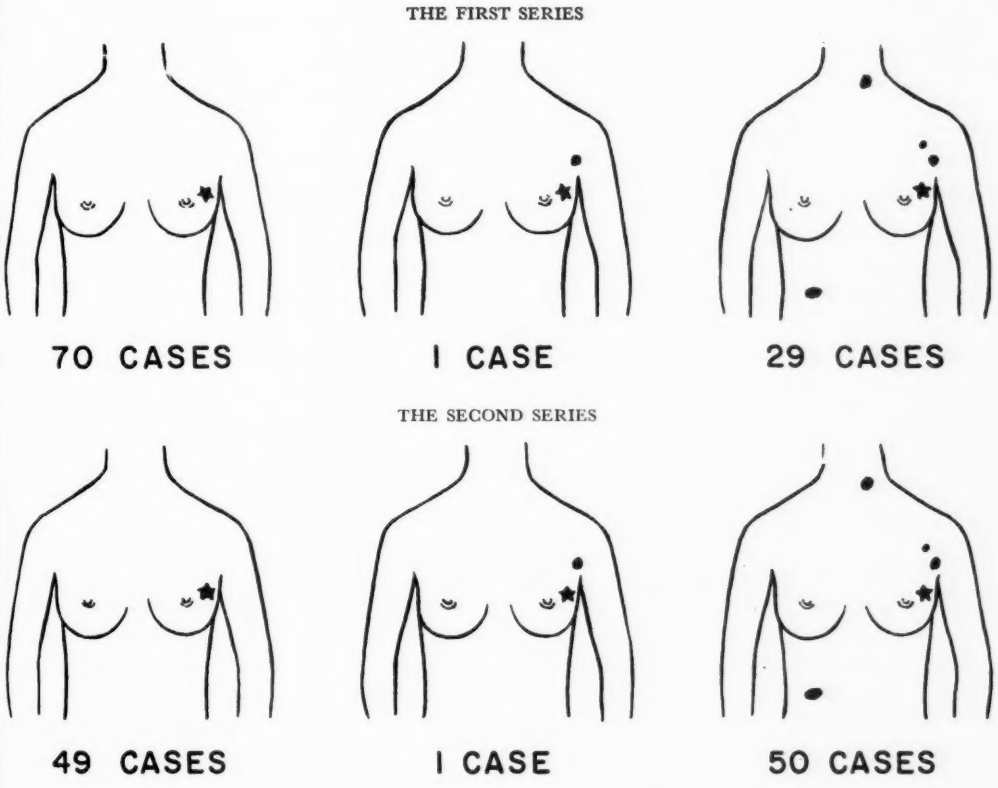
Two young surgeons came to the city in which Doctor Jones practiced. The first was trained abroad and preferred to treat cancer of the breast with simple mastectomy. His practice grew rapidly, and he soon accumulated 100 cases. Doctor Jones followed his progress with interest and could see the distribution of the tumor in these cases. He made the tabulation of the first series shown in the accompanying illustration and noted that the rate of survival, with simple mastectomy, was 70 per cent.

The second young surgeon believed in the radical method; his practice was also quickly established, and he had soon treated 100 cases of breast cancer. Doctor Jones also made a tabulation of these cases (the second series) and noted that the rate of survival, with radical mastectomy, was 50 per cent.

Some time later, the two young surgeons met at a conference and discussed their results. The first proudly announced that his rate of survival was 70 per cent, and opined that simple mastectomy is superior to the radical method. "After all," he said, "I have cured 20 more cases than you." The second young surgeon congratulated his colleague but privately believed that the favorable result was due to a careful selection of patients for treatment rather than to a superior accomplishment of the conservative method. Both surgeons then returned to their practices and continued to apply their usual methods.

Doctor Jones mused over this incident. He could see that if the surgeon preferring radical mastectomy had treated the first series of cases instead of the second, the rate of survival would have been 71 per cent, and if the surgeon preferring simple mastectomy had treated the second series of cases instead of the first, the rate of survival would have been 49 per cent. In this event, the "radical surgeon" would have claimed superiority for his method, and the "conservative surgeon" might have privately assumed that case selectivity, rather than superiority of the method, accounted for the difference. Thus, when the result of treatment favored the

From the Institute of Pathology, Western Reserve University, School of Medicine, Cleveland.



concept of either surgeon, each assumed that the rate of survival expressed the accomplishment of the method, but when the result was adverse to the concept of the surgeon, both assumed that case selectivity precluded the result from disclosing the true worth of the method. In this way, each adjusted his interpretation so that the rate of survival could only support, but not detract from, his concept of therapy. Therefore, it did not appear likely that a comparison of survival rates would reveal to either surgeon which method was superior.

Doctor Jones could see through this dilemma because of his remarkable vision. He saw that both methods would achieve nearly the same result in either series, and thus he knew that the rate of survival does not express the accomplishment of the method as his young friends were prone to suppose. The accomplishment of the method is the volume of tissue cleared of tumor, since tumor within that tissue cannot recur within the patient. The rate of survival is chiefly dependent on the spread of the tumor at the time of treatment, and is high or low depending on which series is treated, but not on which method is used. Since only a small proportion of cases in any series is curable by one method but not by the other, and since that proportion is inconstant, Doctor Jones concluded that it would be extremely difficult to identify the superior method by a comparison of survival rates even if the series were large.

Looking again at the distribution of the tumor in the two series of cases, Doctor Jones saw that 1 patient in each series would be cured by the radical method but not by the conservative method. Without the ability to see the distribution of the tumor im-

plants, neither surgeon could have determined which patient this was. Therefore, Doctor Jones realized that the only rule both surgeons could use that would consistently provide the best result was to select the method that eradicated tumor from the largest amount of tissue at the earliest moment without excessive risk. If both surgeons had used this rule in selecting their methods, both would have used radical mastectomy, and 1 additional patient in whichever series was treated by simple mastectomy would have been saved. Doctor Jones thus concluded that selecting the method according to compliance with the principle of treatment is a more reliable guide to the best result than is selecting the method according to a comparison of survival rates.

Doctor Jones then considered what would have happened if both series had been treated by the radical method. The rate of survival for the first series would have been 71 per cent, and for the second series, 50 per cent. The two young surgeons, still assuming that the rate of survival expresses the accomplishment of the method, would have concluded that one was more skillful than the other. However, Doctor Jones would avoid this conclusion because he could see that the radical method eradicated tumor from the same amount of tissue in both series. He defined the rate of survival, not as the accomplishment of the method, but as the proportion of cases in which all of the tumor lay within the tissue ablated by the method. Therefore, he interpreted the two results according to the factors that determine the distribution of the malignant deposits in relation to the boundaries of the tissue cleared of tumor by the method of treatment. These factors were, in a word, time, malignancy, and resistance. For a series of patients, of course, these factors were cumulative. Doctor Jones would thus attribute the favorable result to a low degree of malignancy of the tumor cells, a high degree of host resistance, or a short interval between the onset of the tumor and the time of treatment. The unfavorable result he would attribute to a high property of invasiveness of the tumor, a low degree of host resistance, or a long interval between the onset of the process and the application of treatment. It was in this context that Doctor Jones thought that further study of survival rates might prove especially useful.

He regretted that he could not impart his visual ability to his young colleagues since in this event his concept would become so convincingly clear.

ON THE IMPORTANCE OF "WEASEL WORDS" IN SURGICAL PATHOLOGY

ALVAN G. FORAKER, M.D., Jacksonville, Florida

"WEASEL WORDS" may render the biopsy report infuriating to the surgeon. A clinically obvious diagnosis may not be confirmed. The report may seem unduly guarded and nondiagnostic. The surgeon knows the patient's total picture, including symptoms, signs, progress, findings at surgery, and all laboratory results. These may or may not be known to the pathologist. Each pathologist hopefully designs a referral form, on which he would appreciate information to accompany the biopsy specimen. This information may or may not appear spontaneously. Even when available or when procured, the cautious pathologist may not be able to render a diagnosis wholly pleasing to the surgeon.

Sometimes this may result from an incorrect clinical evaluation of the nature of the lesion. The presumed ulcer may be a carcinoma, or vice versa. This should occasion no lasting distress. If the surgeon could evaluate every lesion correctly, there would be no need for tissue diagnosis. The surgical pathologist would go the way of the phlebotomist.

More frequently the biopsy specimen may not be representative of the true nature of the lesion. This finding is one of the major limitations of surgical pathology as compared to clinical chemistry. If a blood glucose is reported as 436 milligrams per cent, it is reasonable to assume that the patient had some degree of hyperglycemia in every portion of his body when the blood was drawn. If a biopsy from the esophagus is reported "ulcer of mucosa, with submucosal chronic inflammation," this may or may not indicate the most important esophageal lesion. Another biopsy, a few millimeters away, might reveal infiltrating squamous cell carcinoma. This circumstance may be a source of tension between clinician and pathologist. The biopsy may have been obtained with some difficulty from abnormal appearing tissue adjoining a clinically obvious carcinoma. Alas, it may only represent inflammation and swelling near the tumor. Pathologists have not yet learned to make tumor diagnoses from tissue taken near the lesion. Extrasensory perception has not yet become a part of the orthodox surgical pathologist's armamentarium.

Let us suppose that the surgeon has succeeded in making the patient, the attendants, and the externals co-operate, according to the instructions of Hippocrates. Even then, the surgical pathology report may not be wholly diagnostic. The surgical pathologist is in an analogous position to the blind man grasping the elephant's tail. He cannot discourse on the anatomy of the whole animal. Frequently the surgical pathology report is diagnostic, and may stand by itself, as for example "Squamous cell carcinoma, grade I, of skin (margins of excision free of tumor)." In other cases the microscopic slides may reveal information of marked ancillary value, but not intrinsically diagnostic. A nasopharyngeal biopsy may be reported "submucosal infiltrate of plasma cells, see note." This is all that the pathologist can say with certainty. His note or comment should contain a brief discussion as to diagnostic possibilities. It may well be that other clinical and laboratory studies will enable the clinician to identify the underlying disorder, perhaps multiple myeloma. In such cases, the biopsy report is of marked assistance, even if no self-sufficient diagnosis is offered by the surgical pathologist.

From the Pathology Laboratory, Baptist Memorial Hospital, Jacksonville, Florida.

The biopsy report may indicate the basic nature of the lesion but cannot encompass its total biologic potential. This fact is most characteristic of reports of "intraepithelial" or "in situ" carcinoma. The pathologist is reporting that he sees neoplastic epithelium, with no invasion in the slides he examines. He cannot rule out invasive carcinoma elsewhere in the organ involved. The lesion may be a wholly surface growth, without invasion. It may be a surface growth adjacent to true invasion with metastasizing propensities. Unless full understanding on this point exists between surgeon and pathologist, the interest of the patient will suffer. If the biopsy is submitted, without information, from surface growth at the edge of an obvious carcinoma and the incautious pathologist submits an "in situ" report, he lays himself open to clinical derision. If there is no clinically evident invasion and the "in situ" report of a small biopsy is used as the final authority, incorrect management may result. A conservative clinician may decide to observe the patient while a small invasive carcinoma grows and spreads. Another clinician may elect a regimen of surgery or radiotherapy which would be inadequate if invasion has truly begun. Frequently additional studies, as for example, conization of the uterine cervix, are necessary before definitive management can be planned. It might be better to avoid the terms "in situ" or "intraepithelial" in the tissue diagnosis report. A more accurate phraseology might read, "Squamous cell carcinoma, surface growth, no evidence of invasion in this material." This is semantically awkward. The writer usually puts down the conventional term "intraepithelial carcinoma" with a qualifying comment.

The surgical pathologist's diagnosis should be limited to the findings of his gross and microscopic studies. He should be exact and definite when possible. He should qualify his terms when necessary. Frequently, he can identify the basic nature of the pathologic process but cannot specify its primary site, or even the tissue from which the biopsy was taken. Squamous cell carcinoma arising in the esophagus appears much like that from other mucosal surfaces, as in the vagina. The surgical pathologist's diagnosis should specify what he knows from personal observation. His report should indicate distinctly, for clarification, the points on which he depends on clinical information. This is particularly important when multiple lesions are examined from different portions of the body. One method is to put the designated sites of biopsy in parentheses: "A (tip of nose). Basal cell carcinoma of skin. B (right hand). Dermal nevus."

The biopsy report should be complete, accurate, and informative but "weasel words" may be necessary. Surgical pathologist and clinician should understand the limitations of the facets of medicine practiced by each other. The surgical pathologist is the clinician's consultant for tissue diagnosis. Full co-operation and mutual understanding are just as necessary in this field as they are in other forms of medical consultation.

THE SURGEON AT WORK

A STUDY OF INTESTINAL INTUBATION USING A FLEXIBLE STYLET WITH A CONTROLLABLE TIP

GRAFTON A. SMITH, M.D., Ph.D., F.A.C.S., Columbia, Missouri

INTESTINAL INTUBATION with subsequent suction as an adjunct in the management of intestinal obstruction has proved to be of great value during the past 25 years. The early technical design of the long intestinal tube left much to be desired in the realm of rapid passage into the jejunum and early relief of distention. Ten years ago, a flexible stylet made to guide a long intestinal tube into the upper small bowel was developed (1, 2). This apparatus has been used in 554 trials at intubation among patients with intestinal obstruction. Of these, this method of passage of the intestinal tube into the bowel was attempted prior to surgical intervention with the aid of fluoroscopic visualization in 443 trials and at the time of laparotomy in 111 trials.

A progress report defining this method of intubation, its successful passage rates, and the results of relief of distention among patients treated by a trial of intestinal suction are described herein. The adaptation of this apparatus for passage of the long intestinal tube during surgery when the findings indicate the necessity of immediate laparotomy will be presented as a second portion of this study.

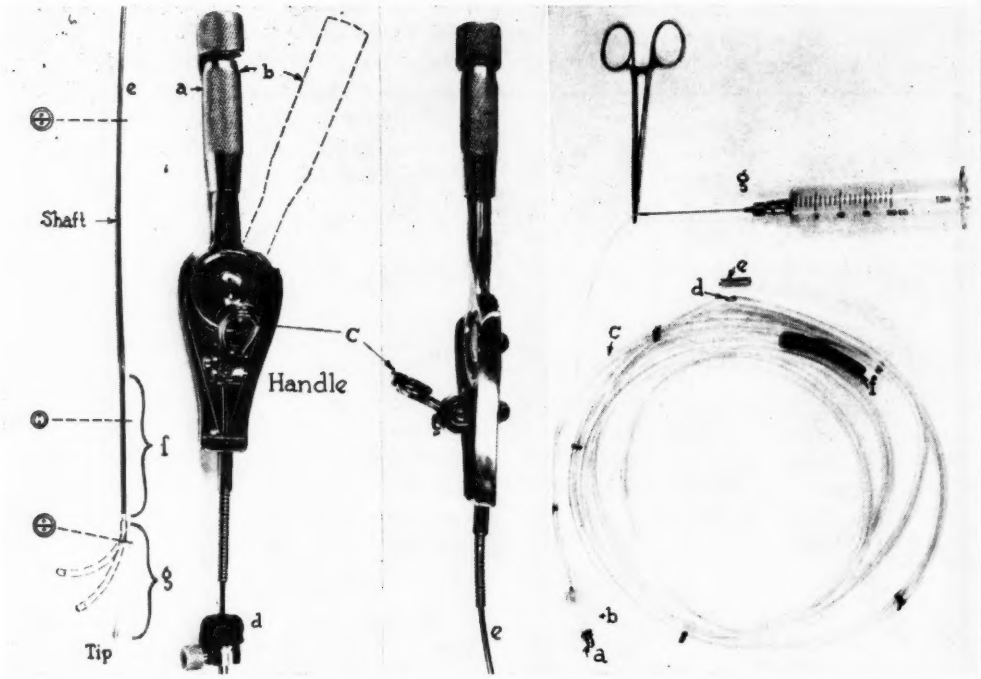
METHOD

The mechanical principles of the apparatus and its clinical application are given in Figures 1 and 2.

Variations in technique are warranted under special circumstances. Here, changing the position of the patient plays a relatively minor role, but turning the patient on his right side can be helpful. This position shows the close relationship of the tube to the spine when the stainless steel tip lies at or within the first portion of the duodenum. Occasionally, it has been helpful to place the patient upon his abdomen while traversing the stomach. The upright position can, in some instances, afford easier passage through the pylorus and should be very helpful among patients who have had previous gastroenterostomies, with or without concomitant gastrectomy.

Furthermore, the passageway into and through the first portion of the duodenum can be difficult due to its position and tortuosity. The controllable tip and the tubing may prove to be lacking flexibility sufficient to slip into and through these angles and turns without a flexible leading finger. This finger to lead the stylet can easily be provided because, when the stylet is retracted 6 centimeters from the stainless tip, the tubing will then act as a leading, flexible finger for transgressing the tortuous duodenum. The fixed position of the duodenum in patients with a very large stomach can be troublesome. In these cases, the redundant stomach is easily displaced into the lower abdomen or pelvis as the semirigid stylet and tube traverse the greater curvature. The help of the gloved hand in placing pressure upon the abdomen and along the greater curvature of the stomach maintains a smaller area within the upper abdomen and therefore allows the stylet to reach the region of the pylorus and duodenum.

If all of these efforts fail, the technique described in Figure 3 should be most helpful. The latter technique is highly recommended for use in a cascade or sharply transverse type of stomach.



a b

FIG. 1. Flexible stylet with a controllable tip and plastic tube. The stylet and tube are constructed to enable controlled rapid intubation of the small bowel. The stylet is designed to serve two functions: To direct the long intestinal tube toward the pylorus by manipulation of the controllable tip; enable advancement of the tube into the small bowel through the transformation of the flexible stylet into a semirigid shaft. a, The stylet is illustrated and diagrammatically shows the deflection of the tip when the director lever (*a*) of the handle is turned. Movement of the director lever to the right (*b*) shortens one of 2 small wires traversing the flexible shaft (*e* and *f*) connecting with the controllable tip (*g*). This maneuver curves the tip to the right. On the director lever (*a*) is a knurled sliding sleeve for fine adjustment of the tension imposed upon the small wires attached to the controllable tip. Rotation of this sleeve to the left increases maneuverability of the tip (*g*) and slightly stiffens the small shaft (*f*). Increased flexibility of the leading portion of the stylet is afforded by turning the sleeve to the right for passage through the duodenum and small bowel. The thumb lever (*c*) is attached to a flat wire which terminates at the junction of the larger (*e*) and smaller (*f*) portions of the shaft. Pressure exerted on the thumb lever transforms the proximal segment of the flexible shaft (*e*) into a semirigid column without affecting the flexibility of the distal 10 centimeters of the stylet. This maneuver enables the operator to transform the flexible stylet into a semirigid shaft with "flexible leading finger" and affords a safe instrument for passage into the intestine. The air adaptor (*d*) is attached to the tube for inflation of the stomach prior to manipulating the tip. b, The tube is 9 feet long and is made of plastic. A stainless steel tip (*a*) is cemented and tied into its end. Two holes, one on each side of the plug, connect with the lumen of the tube and serve as the avenue of suction distal to the latex balloon (*b*). The balloon is inflated with air through the small plastic tubing (*c*). A hole is cut in the wall of the large tube 4 feet from the balloon for insertion of the stylet (*e*). A short segment of intravenous tubing (*f*) serves as a connection to the suction apparatus. The syringe (*g*) in place for inflation or deflation of the balloon.

MATERIALS

The material presented is taken from observations at the time of intubation, from physical examinations, and from hospital charts and roentgenograms. Concerning the initial intubation, the trial was considered successful if the tube was placed in the second part of the duodenum or beyond. Among patients with gastroenterostomy, a successful passage was established when the tube had entered 30 centimeters into the efferent loop. The intubation period was considered as the time required for passage of the tube orally into the small bowel and then removal of the stylet.

FIG. 2. Diagram of the technique of intubation using the flexible stylet with a controllable tip. a, The long intestinal tube is inserted into the stomach. Passage along the greater curvature toward the right simplifies the procedure and the operator proceeds directly to intubate the small bowel. When the tube coils in the fundus, it is retracted to the position indicated. b, The stomach is distended with 700 to 1,000 cubic centimeters of air and the controllable tip is turned toward the pylorus. c, The semirigid stylet and tubing are advanced to exert pressure on the pylorus. Here, the stylet may be withdrawn to the position indicated (insert) to take advantage of the greater flexibility of the leading tip of the tube, alone, in traversing the tortuous first portion of the duodenum. d, It is then passed into the third portion of the duodenum. In the event that progression of the tube through the third portion of the duodenum is not rapid, the duodenum may also be inflated with air (insert d) as was accomplished within the stomach. e, Previous to advancement of the tube, the marked angularity or kinking of the tube within the stomach is decreased by the removal of excess tubing and then the stylet may be partially extracted from the tubing until its tip is within the region of the pylorus. f, The stylet and tubing are advanced together until the tip of the tube is within the jejunum and the tip of the stylet in the second portion of the duodenum. g, Following repeated partial removal of the stylet and then insertion of the tube and stylet, as shown in e and f, the long intestinal tube is well into the jejunum. The stylet is then removed and the balloon is inflated with 10 cubic centimeters of air.

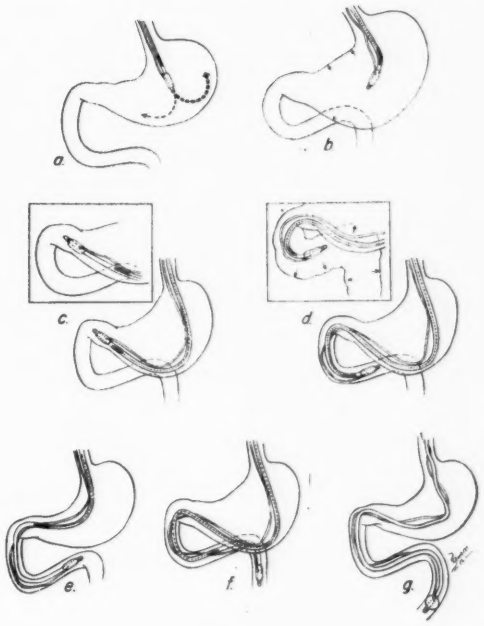


FIG. 2.

The time required for successful decompression using intestinal suction was determined by clinical and roentgenographic findings. Decompression was considered adequate by physical examination if the abdomen was soft and flat and/or the x-ray film of the abdomen indicated loops of bowel less than 4 centimeters in caliber. The status of patients with small bowel obstruction was reported as severe distention, or moderate to slight distention, as demonstrated by x-ray films. In the former group, the abdomen was tightly distended, and loops of small bowel were found to be greater than 5 centimeters in diameter upon roentgenographic examination. Here, there was lengthening of the loops with fluid levels and wide separation of Kerckring's folds. In the latter group, with moderate to slight distention, the abdomen had become tense and definite lengthening of the intestinal loops occurred, but the diameter of the lumen measured less than 5 centimeters. Decompression rates were considered only for those patients in whom suction had an uninterrupted trial for 24 hours or longer.

Another and entirely separate group of patients, those subjected to intestinal intubation for diagnostic purposes in the absence of intestinal obstruction, merits only brief consideration. In these 35 patients, other attempts at intubation by alternate methods had failed or intubation, for various reasons, had been considered especially difficult. Among this group there were 5 failures, a rate of 14 per cent. The remaining 443 attempts at intubation under fluoroscopic guidance were directed to relieve distention in patients with intestinal obstruction and constitute the material presented herein.

RESULTS OF INITIAL INTUBATION

The rapidity and success of intubation using the stylet with a controllable tip for intestinal obstruction are as follows: In 443 trials at intubation, 89 per cent were successful, and more than three-fourths (348) were completed in less than 30 minutes (79 per cent). Actually, in one-half of those patients in whom the tube was not passed, the findings at exploratory laparotomy indicated constriction of the bowel lumen (due to scarring, adhesions, or tumors) sufficient to block the passage of the intestinal tube completely. The remaining failures could not be so explained, and in these the anatomically

TABLE I.—SUCCESSFUL PLACEMENT OF INTESTINAL TUBE AT INITIAL INTUBATION FOR VARIOUS TYPES OF OBSTRUCTION, 443 TRIALS

Site of placement	*Mechanical small bowel (complete)*	*Mechanical large bowel (partial)*	*Paralytic ileus*	*Total*	
				No.	*Per cent*
Jejunum	227	34	48	309	70
Duodenum	55	13	16	84	19
Failures,					
No.	31	5	14	50	11
Per cent	10	10	18		
Total	313	52	78	443	100

TABLE II.—RESULTS OF INTESTINAL INTUBATION FOR VARIOUS TYPES OF INTESTINAL OBSTRUCTION

	Small bowel	*Large bowel*	*Ileus*	*Total*
Total No. intubations*	306	52	78	443
Total No. patients†	292	52	74	418
No. failures	31	5	14	50
No. patients with successful intubations	261	47	60	368
No. patients with inadequate trial of suction‡	38	19	6	63
No. patients having adequate trial of suction	223	28	54	305

*7 patients in whom data for analysis of decompression was lacking.
†2 patients intubated 3 times; 14 patients intubated 2 times; 402 patients intubated 1 time.
‡Early surgery interrupted suction; in a few cases the patient pulled the tube out.

transverse stomach or the cascade variation contributed most often to failure.

In addition to being both successful and rapid, the use of the stylet frequently affords initial placement of the tube well into the upper reaches of the small bowel. Of all attempts at intubation, nearly 70 per cent were placed within the jejunum during visualization at the time of fluoroscopy (Table I). Although the failure rates were low for all of the various types of obstruction, insertion of the tube in cases of paralytic ileus was definitely less successful than it was in mechanical obstruction of either the small or large bowel. Finally, among those patients in whom intubation was successful, the tube was manipulated into the jejunum equally well in cases of mechanical obstruction or paralytic ileus.

RESULTS OF INTESTINAL DECOMPRESSION

The rewards of successful intestinal intubation could be measured most reasonably among the patients with various types of obstruction in whom the suction had an uninterrupted trial for a period of 24 hours or longer (Table II). The obstructions in these instances were so diagnosed

TABLE III.—MECHANICAL SMALL BOWEL OBSTRUCTIONS DECOMPRESSION RATES, 223 CASES

Rates	*Degree of distention*					
	Moderate to slight		*Severe*		*Total*	
	No.	*Per cent*	*No.*	*Per cent*	*No.*	*Per cent*
Less than 24 hours	59	52	49	45	108	48
25 to 48 hours	30	26	40	37	70	31
48 hours or longer	19	17	10	9	29	13
Total No. successful decompressions	108	95	99	91	207	93
Failure of decompression	6	5	10	9	16	7
	114	100	109	100	223	100

TABLE IV.—INTESTINAL ILEUS DECOMPRESSION RATES FOR TRIALS OF SUCTION, 54 CASES

Rates	*No. cases*	*Per cent of total*
Less than 24 hours	21	39
25 hours to 48 hours	15	28
48 hours or longer	15	28
Failures	3	5
Total	54	100

as to make it possible to delay surgery. For other patients, it was deemed advisable to interrupt suction and to operate without completing the trial of suction. The patients were regularly observed for any change in physical findings or symptoms. Of course, interruption was most frequent in the problem of colic obstruction when the passage of gas and fluid from the lower ileum, beyond the immediate reach of the intestinal suction, could further dangerously dilate the cecum. The earlier surgical treatment for distention of the small bowel was initiated most frequently because of localized tenderness or when the suspicion of strangulating obstruction became apparent. Finally, and less frequently, those patients with paralytic ileus were operated upon when the distention was sufficient to endanger the blood supply to the lower bowel, especially the cecum.

The rates of decompression for patients with small bowel obstruction, who received an adequate trial of suction, are given in Table III. It is interesting to note that in almost one-half of these patients decompression was successfully completed in less than 24 hours. In less than 48 hours, more than three-fourths of all patients with small bowel obstruction were completely relieved of distention. As might be expected, those with severe distention required a slightly longer period for decompression; however, at the end of 48 hours this difference no longer existed. Although the number of decompressions con-

FIG. 3. An alternate technique of intubation using the flexible stylet with a controllable tip with the addition of mercury within the balloon to serve as a gravity director. a, The long intestinal tube is inserted into the stomach. Then the stomach is distended with 700 to 1,000 cubic centimeters of air, and the tip of the stylet is positioned so as to rest approximately 6 centimeters from the end of the tube as shown by fluoroscopy. b, The patient is turned on his right side and the semirigid stylet and tube are advanced until they cross the midline. c, The patient's head is also lowered so the mercury-weighted balloon will pass toward the duodenal bulb. At this point continuous pressure by the semirigid stylet affords rapid passage into the upper second portion of the duodenum. d, The patient assumes a new position by lying supine with the head elevated above the feet to afford rapid passage through the second portion of the duodenum. e, The duodenum is then inflated so as to become distended with air to afford passage of the weighted tip into the third portion. f, Further rapid advancement is aided by placing the patient on his left side. g, This is accomplished by insertion of the tube and semirigid stylet together into the lower reaches of the bowel. h, Finally, the patient is placed in the upright position and the mercury-weighted tube falls into the jejunum. i, The balloon is then inflated with 10 cubic centimeters of air and the stylet is extracted. Attachment to suction is afforded as described in Figure 1.

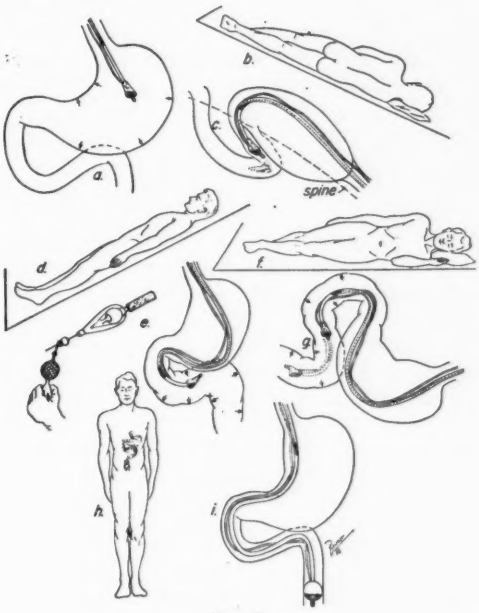


FIG. 3.

sidered as complete failures was few, the rates were only slightly greater among patients with severe distention than in those with lesser dilatation of the bowel.

Decompression in cases of large bowel obstruction was very slow in comparison with the other two groups. In one-half of these patients it took longer than 48 hours; and the number of failures of decompression was appreciably greater than in patients with either small bowel obstruction or ileus.

The results of decompression in patients with paralytic ileus are given in Table IV. The time required for decompression is somewhat longer than that for mechanical small bowel obstruction because of decreased motility of the bowel and retarded descent of the catheter. Nevertheless, this group showed the lowest failure rate.

COMMENTS

Indications and contraindications for the application of intestinal suction in the management of intestinal obstruction have been widely discussed. The attempt here has been only to describe the results in the relief and control of intestinal distention applying a flexible stylet with controllable tip to direct the long intestinal tube into the upper reaches of the small bowel.

In the total picture, many factors played a role in the success or failure at passage of a long tube to initiate a trial of suction therapy; but, over-all, the failure rate was very low (11 per cent). Results were collected from the records in which many residents and surgeons attempted intubation. Their experience in the handling of intestinal obstruction varied widely, a significant factor favoring the application of this technique by others. Also of interest is the fact that severity of bowel distention did not impede entry of the long tube into the bowel. But contrary to expectation, the passage was successful in 10 per cent of those patients with severe distention as compared to 13 per cent among those with moderate to slight distention. Passage rates showed no great difference in the various types of obstruction; however, the failure in the ileus group (18 per cent) was higher than in either the small bowel group (10 per cent) or the large bowel group (10 per cent). Of practical importance is the fact that nearly 80 per cent of all patients with obstruction were successfully intubated in less than 30 minutes. Furthermore, it was possible initially to place the long tube well within the jejunum in nearly 70 per cent of

all attempts. The method was not only rapid but safe. There were no punctures of the gastrointestinal tract or any other discernible injuries during passage of the tube.

The number of successful decompressions, after an adequate trial of suction, was high in all groups of obstruction. But the time required for decompression varied markedly as to the type of obstruction. The distended small bowel with active peristalsis was most efficiently decompressed. Paralytic ileus thwarted rapid decompression, but eventual relief of distention was most successful in these cases. These successes would strongly indicate the continued use of the long intestinal tube for the control of distention among patients with these simple types of obstruction. Even if surgery is required to relieve the obstructive mechanism, the surgeon is confronted with a lesser problem in the absence of the massive loops of distended bowel. On the other hand, colic obstruction was relieved slowly and attended by the greatest failure rate. Certainly, remarkable dilatation of the colon can be better treated by the application of surgical intervention and colostomy.

CONCLUSIONS AND SUMMARY

The clinical application of a rapid method of intubation, its successful passage rate, and its success in effecting decompression among patients with intestinal obstruction has been reviewed. In all, 443 trials of intubation were attempted under fluoroscopic visualization to achieve intestinal decompression among patients with bowel obstruction. The long intestinal tube was successfully passed into the duodenum or jejunum in 89 per cent of these attempts. This was accomplished in less than 30 minutes in more than three-fourths of the cases. The rapid successful catheterization among patients with either mechanical obstruction or paralytic ileus would recommend that this technique be widely employed.

The efficiency of decompression of the dilated intestine using this apparatus was quite remarkable. Relief of distention in less than 24 hours was accomplished in one-half of the patients with mechanical obstruction of the small bowel when the trial of suction continued without interruption. Eventually, decompression was successful in 93 per cent. On the other hand, the success of initial intubation among patients with partial large bowel obstruction was overshadowed by the length of time required for decompression and the higher failure rate in achieving relief of distention. One-half of these patients required more than 24 hours to gain relief of distention, and in 82 per cent decompression was finally successful. Thus, intubation and suction could not be recommended as the principal management for patients with partial obstruction of the large bowel.

In the treatment of paralytic ileus, the successful passage of the catheter with relief of distention was less effective than among those patients with mechanical obstruction. The relief of distention was accomplished in only 39 per cent of these patients in less than 24 hours but eventually suction successfully decompressed the bowel in 95 per cent of these cases. Although decompression was considerably slower than one might desire, the ultimate success rate should warrant the continued use of a trial of suction as an effective method of management of this problem.

REFERENCES

1. Smith, Grafton A. A study of intestinal intubation using a flexible stylet with controllable tip. Surgery, 1952, 32: 17–30.
2. Smith, Grafton A., and Brackney, Edwin L. Preliminary report on a new method of intestinal intubation with the aid of a flexible stylet with controllable tip. Surgery, 1950, 27: 817–821.

MYOCARDIAL FLAP TECHNIQUE FOR THE CORRECTION OF TETRALOGY OF FALLOT

WILLIAM P. LONGMIRE, JR., M.D., F.A.C.S., DONALD G. MULDER, M.D., and JAMES V. MALONEY, JR., M.D., F.A.C.S., Los Angeles, California

WITH THE DEVELOPMENT of techniques for extracorporeal circulation employing a heart-lung machine, most congenital cardiac malformations can be surgically corrected. In many instances, if adequate tissue is not available, repair may be accomplished by suturing a polyvinyl sponge or similar prosthesis into the defect. This material seems to be well tolerated by the body, and histologic study of Mortensen for varying periods of time has shown that tissues will grow into the interstices of the sponge and incorporate it into a firm and presumably permanent scar.

In general, the use of a patient's own tissues is preferred to that of a foreign body. In this regard, we should like to present another technique which has proved quite satisfactory in the treatment of tetralogy of Fallot.

After extracorporeal circulation is instituted, Melrose solution is injected into the proximal root of the cross-clamped aorta to arrest the heart.[1] The right ventricle is opened in the direction of the outflow tract up to the base of the pulmonic valve. The ventricular defect is clearly outlined and its relationship to the aortic valves is carefully noted. Occasionally, although infrequently, the defect is small and can be closed by direct suture. Care must be taken to close it in such a manner that the suture line is transverse, or at right angles, to the left ventricular outflow tract as recommended by Kirklin. In most instances, the defect is so large that some prosthesis or adjacent tissue will be needed to close it. Directly anterior and cephalad to the defect, the hypertrophied supraventricular crest will be noted. Rather than sacrifice this obstructing ring of tissue in its entirety, a myocardial flap is fashioned (Fig. 1).

Two parallel incisions are made into the midportion of the infundibular collar delineating the myocardial flap (Fig. 1a). The remaining obstructing infundibular muscle is excised laterally on either side of the myocardial flap to increase the lumen of the outflow tract (Fig. 1b). This flap, with its base attached to the posterior or dorsal aspect of the right ventricular outflow tract, is swung downward and sutured securely to the now crescent-shaped inferior and lateral

From the Department of Surgery, University of California Medical Center, Los Angeles.

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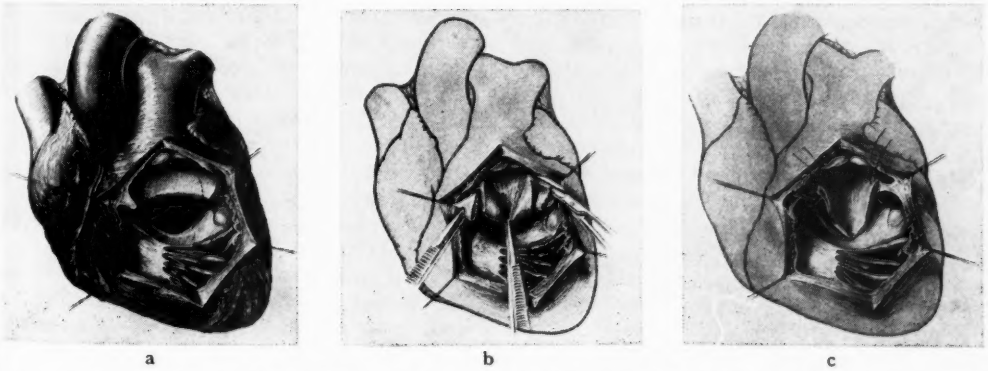
[1]Anoxic arrest is now preferred.



a b c

FIG. 1. a, Myocardial flap delineated. b, Remaining obstructing infundibular muscle is excised. c, Flap sutured to margins of ventricular defect.

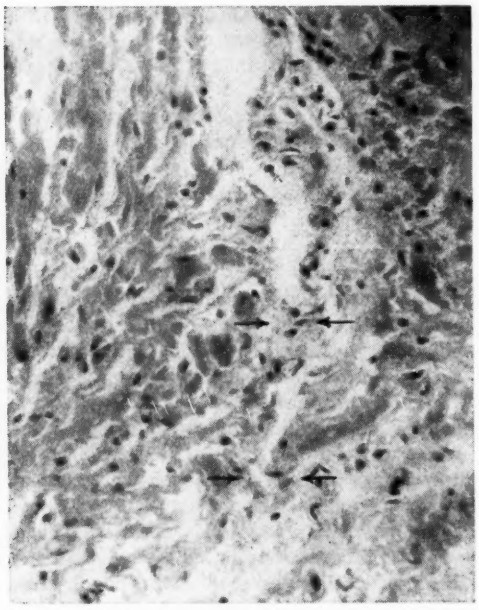


FIG. 2. Photomicrograph taken 2 weeks postoperatively showing viable flap and early healing.

edges of the ventricular defect with interrupted silk sutures (Fig. 1c). This method is technically easier and quicker than using a prosthetic patch. If the flap is fashioned correctly, there is no tension on the suture line, and closure is quite satisfactory. Postmortem examination 2 weeks postoperatively in 1 patient revealed an intact myocardial flap closure with evidence of early healing. If a small and inadequate outflow tract is present, the ventricular incision is carried through the pulmonary valve toward the bifurcation of the main pulmonary artery. An "outflow tract roof" of polyvinyl sponge is inserted in these cases as advocated by Warden and Lillehei. Because of the abundant collateral pulmonary circulation in the patient with tetralogy of Fallot, it has been found helpful for accurate suturing to place an aspirating cannula into the left atrium during bypass to keep the left side of the heart dry.

The myocardial flap technique has been employed in only half of the patients operated upon for tetralogy of Fallot. In many instances, the heart is anatomically unsuitable for this technique because of the large size of the ventricular defect and because of the inadequacy of the infundibular tissue available for construction of a flap. With the use of this method there are advantages of technical ease and the avoidance of the use of foreign material within the heart.

REFERENCES

1. KIRKLIN, J. W. Surgical technique for repair of high ventricular septal defects. J. Thorac. Surg., 1958, 35: 584.
2. MORTENSEN, J. D. Molded, seamless tubes of polyvinyl formalized sponge. Arch. Surg., 1953, 72: 871.
3. WARDEN, H. E., and LILLEHEI, C. W. A surgical-pathologic classification for isolated ventricular septal defects and for those in Fallot's tetralogy. J. Thorac. Surg., 1957, 33: 21.

THE SURGEON'S LIBRARY

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THE HISTORICAL IMPORTANCE OF GUNSHOT WOUNDS IN THE RENAISSANCE AND PROGRESS OF SURGERY

STACEY B. DAY, Minneapolis, Minnesota

MEN believe in progress not as an ideal but as an indisputable fact, as a law of nature. The early civilizations of mankind endeavored to preserve the wisdom and virtue of the past; contemporary societies endeavor to anticipate the wisdom and virtue of the future. In surgery as in all the disciplines of life, such wisdom and virtue are slowly and arduously won.

In early Greek and Roman society, surgery was an established art. By the end of the Middle Ages in Europe, however, its eclipse was complete. Surgery and medicine became completely dissociated, and with the pronouncement of the Council of Tours in 1163 *Ecclesia abhorret a sanguine* (the Church does not shed blood) surgical teaching and tractates gradually disappeared from the Universities, so that by the thirteenth century surgery was practiced by men of widely differing quality. In effect, the surgeon had now become a tradesman while the physician remained a learned graduate of the Universities, schooled in Latin and frequently a cleric. Surgery in these times was relegated to barbers, bath keepers, hangmen, sow gelders, and others who for social or religious reasons could not obtain a degree. In medieval Germany, England, and Ireland particularly, practitioners were incorporated as one of the several trade guilds. United with barbers, periwig makers, and completely uneducated persons who relied on manual dexterity, the practice of surgery became increasingly confined to bleeding, cupping, and the extraction of teeth. The first incorporation of barbers and surgeons in the British Isles was celebrated in Dublin on October 18, 1446 under a charter given to the Fraternity or Guild of St. Mary Magdalene by Henry II. Such barber surgeons were known by their insignia—a staff, porringer, and red garter. The staff, which had a sling attached, was customarily used as a support by patients who were being bled. When not in use, the pole was hung outside the premises as a sign of the trade followed within. In order to distinguish them from common tonsorial barbers whose colors were blue and white, the poles of the barber surgeons were painted red and white. Frequently, barber surgeons practiced both arts, which possibly explains the curious retention to this day of the red and white staff by barbers as the emblem of their trade.

The modern surgeon may reflect with interest on the following testimonial given one of his early professional forebears in a letter to Valentine, 3rd Viscount Kenmare written by his aunt in 1718, and preserved in the *Kenmare Papers:*

> I'm recommended a young man who is of very honest parents. He bleeds, shaves, makes wigs, writes, and reads very well, and by what I hear of him would be very fit to be about yourself, and withal might serve in the nature of a butler when you live in the County Kerry.

Yet lowly and unsophisticated as undoubtedly

From the Department of Surgery, University of Minnesota, Minneapolis.

FIG. 1. Arms of London Barber Surgeons, 1451. The charges, which look like an inverted figure two, represent the fleam (lancet) used by surgeons in the days of frequent phlebotomy. These charges first appeared in 1451.

many were, it was these men who kept surgery alive until the sixteenth century when from their ranks emerged the great military surgeons, foremost among whom was Ambroïse Paré (1510–1590). The simplicity of his words (when congratulated on curing a remarkably difficult case he typically replied: "Je le pansay, Dieu le guarit"—I bandaged him, God cured him) and the magnificence of his deeds befit Paré to be acclaimed the father of modern surgery. Society, which paradoxically centuries earlier had forced the surgeon into oblivion, now demanded his rebirth. The introduction of gunpowder, allegedly by Roger Bacon—the Doctor Mirabilis—and in its wake the increased mortality and morbidity attendant on war increased the social need for the surgeon in all walks of life. The rise of the military surgeon and the introduction of treatment of gunshot wounds established the renaissance of surgery and the ultimate elevation of the surgeon to the higher ranks of the professions. With the advent of new weapons of war, surgery was reborn.

THE MILITARY SURGEONS

Although it was the Romance Countries in which anatomic studies, the future foundation for the surgeon, were developed, several of the most important early military surgeons arose from humble ranks in Germany. As would be anticipated, these men were chiefly concerned with wounds of war. The earliest writings on gunshot wounds were those of Heinrich Von Pfolspeundt in 1460, a barber who became a skillful surgeon and who recorded in brilliant, if illiterate terms, the urgency of the problem of gunshot wounds. Possibly too because of the development of the printing press in Germany, the first important manual entitled *Buch der Wund-Artzney* was published in Strassburg in 1497 by Hieronymus Brunschwig. Some doubt exists as to whether Brunschwig had been in fact a military surgeon, but there is *no* doubt that his work is a contribution of outstanding workmanship and sound experience.

Although this book did not offer any original discovery, it did deal explicitly with gunshot wounds and their treatment and included operations and technical procedures of the day. Outstanding among its merits were the beautiful illustrations depicting the costumes, chambers, and instruments (Fig. 3) of fifteenth century surgeons. These pictures have more than fulfilled the purpose for which they were designed. They have preserved for posterity one of the most beautiful books of any century. A few years after Brunschwig, Hans Von Gersdorff, another military surgeon, published in 1517 an account, *Feldtbuch der Wundartzney*, based on 40 years of surgical experience in military campaigns.

Important as these contributions were, however, they had neither the pioneer quality nor the social significance of the observations of Ambroïse Paré whose work was to eclipse all former achievements, and who was destined to raise surgery to a hitherto unknown level.

Born in 1510 the son of a barber surgeon at Bourg Hersent near Laval in the Maine province of France, Paré made his first outstanding contribution to surgery at 26 years of age. The oft quoted words in which he expressed his belief that the prevailing use of boiling oil was detrimental in treating gunshot wounds are so charged with humility and character that neither time nor repetition can dim their frankness:

> Now at that time I was a fresh water souldier, I had not yet seene wounds made by gunshot at the first dressing. It is true I had read John de Vigo, in the first booke of wounds in generall, the eighth chapter, that wounds made by weapons of fire did participate of venenosity, by reason of the pouder, and for their cure commands to cauterise them with oyle of Elders scalding hot, in which should be mingled a little Treackle; and not to saile, before I would apply of the sayd oyle, knowing that such a thing might bring to the patient great paine, I was willing to know first, before I applyed it, how the other Chirurgions did for the first dressing, which was to apply the sayd oyle the hottest that tooke courage to doe as they did. At

last I wanted oyle, and was constrained in steed thereof, to apply a digestive of egges, oyle of roses, and turpentine. In the night I could not sleep in quite, fearing some default in not cauterising that I should finde those to whom I had not used the burning oyle dead impoysoned; which made me rise very early to visit them, where beyond my expectation I found those to whom I had applyed my digestive medicine, to feel little pain, and their wounds without inflammation or tumour, having rested reasonably well in the night; the other to whom was used the sayd burning oyle I found them feverish, with great paine and tumour about the edges of their wounds. And then I resolved with myselfe never so cruelly to burne poore men wounded with gunshot.

Indefatigable and tireless, Paré was the first to indicate that syphilis was the cause of aneurysm. He reintroduced the ligature in 1552 for tying off bleeding arteries and introduced the use of artificial limbs, teeth, and eyes. In obstetrics, he was of equal prowess. His book *De la generation de l'homme* restored the practice of podalic version and gained him renown as a founder of modern obstetrics. As a teacher, he won further acclaim through his pupils Amboïse, Cabrol, and Franco, the latter being the first to perform suprapubic cystotomy and the author of 2 outstanding tractates in surgery, the *Petit traité* in 1556 and the *Grand traité* in 1561.

But it was not alone in the field of surgery that Paré's achievements were outstanding. The implications of his prodigy were of the greatest significance for society. Untutored in the classic sense, his elevation in 1554 to the elite ranks of the College de St. Cosme, in spite of the opposition of the Sorbonne who could not conceive of a member not knowing Latin, and his stature as court surgeon to Henry II, Francis II, and Charles IX anticipated an advance in the status of surgery throughout Europe. The College de St. Cosme had been established in 1286 by Louis IX and was the first College of Surgeons founded in Europe.

The surgeons in Paris had been divided into a hierarchy of elite belonging to the College de St. Cosme, and the despised barber surgeons who performed venesections and less palatable operations. The physicians of the time held themselves vastly superior to both these bodies presumably because they were more familiar with the classical languages and did not work with their hands. Paré, more than any other surgeon in sixteenth century France, was responsible for the elevation of surgery to a position of dignity and esteem. A few years after

FIG. 2. Ambroïse Paré (aged 45). After an engraving attributed to Jean Le Royer, 1561.

his death, Louis XIII (1610–1643) in a *beau geste* commemorating the coincidence of his own birthday on the feast day of SS. Cosmas and Damian raised the College to the status of a Faculty. Conferring upon it the privilege of adding the fleur-de-lis to the College arms together with his own personal motto "Consilio Manuque" Louis declared it to be "his College" and was admitted as an honorary member. Thus, Paris early became a center of surgery in Europe, and with a rise to distinction of this branch of medical science, Dublin, Edinburgh, and London closely followed with the organization of the Royal Colleges pledged to further the training and education of the surgeon.

THE SURGEON IN AMERICA

Meanwhile, prior to the Columbian voyage in 1492, knowledge of a New World existed only in legend and imagination. Thus, while the barber surgeons were organizing in guilds and spending much "time in sterile quarrels

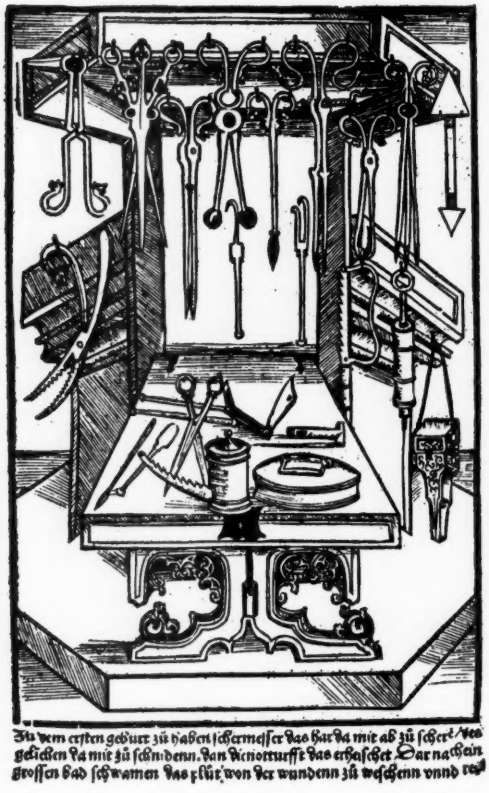


FIG. 3. Surgeons' instruments, fifteenth century. From Brunschwig's *Cirurgia*, the first surgical manual to use illustrations. Published in Strassburg by Johann Gruninger, 1497.

FIG. 4. The "Wound Man" and fifteenth century physician. From Brunschwig's *Cirurgia*. Note the attire of the physician and the variety and site of common wound injuries of the day.

with the physicians" (Sigerist) man's knowledge of the earth remained limited. The 1424 Nautical Chart (Fig. 5)[1] indicates the poverty of knowledge of lands beyond Europe.

With the opening up of the western hemisphere by navigators and explorers, however, and with the urge to trade, to colonize, and to conquer, it was perhaps a logical consequence that surgery should have been carried to the New World by military surgeons. It is perhaps fitting, too, that the first momentous advance contributed by an American surgeon should have been made by a graduate apprentice, trained under the old preceptor system, and an active military surgeon. It was a gunshot wound that led William Beaumont in 1822 to the paths of a new science—gastric physiology. Stationed on Mackinac Island off northern Michigan at the time, Beaumont was called to attend a young voyageur, Alexis St. Martin, who had been accidentally shot. The charge had torn muscles, fractured ribs, and sent buckshot and powder into the wound which penetrated the stomach. Later in his notes Beaumont wrote, "I considered any attempt to save his life entirely useless. But as I have ever considered it a duty to use every means in my power to preserve life.... I proceeded to cleanse the wound and give it a superficial dressing."

At much personal expense and after many

[1]This is a prized example of early fifteenth century cartography. It was formerly a part of the outstanding manuscript collection of Sir Thomas Phillipps and is now in the James Ford Bell Collection at the University of Minnesota. Much scholarship and argument have been provoked over the question of whether the islands to the west of Portugal indicate early knowledge of America.

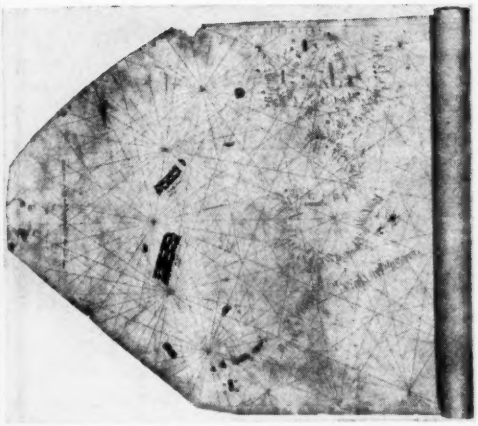
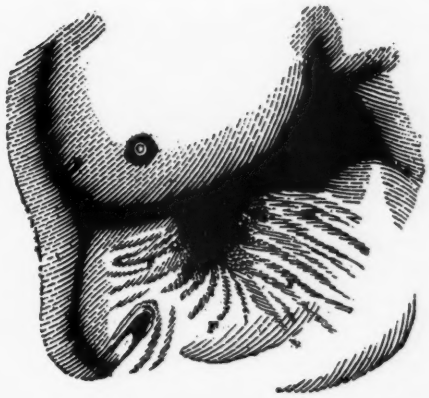


FIG. 5. The 1424 Nautical Chart. Courtesy of James Ford Bell Collection, University of Minnesota.

tribulations, Beaumont nursed St. Martin back to health. Endowed with great scientific curiosity, he commenced his historic experiments on gastric digestion. Writing of the fistula which refused to close and through which he had frequently given cathartics, Beaumont said he had given medicine "as never medicine was given before." Not only did his experiments concern the digestive processes but they extended to the temperature effects on digestion. Military doctors at that time were required to keep meteorologic reports, so that it was quite natural for Beaumont to observe the temperature effects upon food outside and inside the stomach. Finally, in 1833, from Plattsburg in New York, he published his work *Experiments and Observations on the Gastric Juice and the Physiology of Digestion*, the first major contribution to gastric physiology. The imagination that prompted Beaumont to utilize a gastric fistula in studying digestion has been the foundation tool that has served to guide generations of gastric surgeons since his time.

Of historical interest, the "fistulous old Alexis" outlived Beaumont by 27 years and was survived by his wife and 20 children. It is related that at the time of St. Martin's death, William Osler endeavored to obtain consent from the family for an autopsy in order to preserve his stomach. Osler received the following telegram: "Don't come for autopsy. Will be killed." Relatives of Alexis buried the body 8 feet deep and are said to have stood guard over the grave.

Meanwhile, such American graduates as could



This engraving represents the ordinary appearance of the left breast and side, the aperture filled with the valve; the subject in an erect position.

A A A The circumference and edge of the aperture, within which is seen the valve.

B The attachment of the valvular portion of the stomach to the superior part of the aperture.

C The nipple.

D The anterior portion of the breast.

E The scar where the opening was made with the scalpel, and the cartilages taken out.

F F F F Cicatrice of the original wound, around the aperture.

FIG. 6. Engraving of the fistula in Alexis St. Martin. From the experiments and observations of William Beaumont, 1833.

afford a foreign education traveled to Europe for advanced surgical instruction. From these centers men of the genre of Benjamin Rush, John Collins Warren, Oliver Wendell Holmes, Sims, Mott, and Gross returned to earn for American surgery a tradition of skill and great daring. Nevertheless, progress was limited. The American Civil War (1861–1865) provided military surgeons with many types of fracture injury and wound infection, caused by the projectiles used, but little true appreciation of the underlying bacteriologic factors involved. It was during this time that the Medical Museum of the Armed Forces Institute of Pathology began to grow. Specimens of fractured bone, small arm cartridges, and shot from the Civil War are still preserved, and vivid anecdotes frequently center around exhibits. One such story concerns Major General Daniel E. Sickles, United States Volunteers, who at the Battle of Gettysburg on July 2, 1863 had his right leg shattered by a 12 pound solid cannon ball. The leg was amputated and

FIG. 7. Copy of the original sketch of Abraham Lincoln's Death Bed Scene by Hermann Faber. Courtesy of Medical Armed Forces Institute, Museum of Pathology, Walter Reed Army Medical Center, Washington, D. C.

sent by General Sickles to the Army Medical Museum in a rough coffin with a visiting card which read "With the compliments of Major Gen. D.E.S., U.S. Vols." It is said that after the war the General would visit the Museum occasionally to see the bones preserved from his leg.

Then, as now, certain regions of the body remained inviolate. Once injured by gunshot, mortality was inevitable. Such was the case in the fatal shooting of President Abraham Lincoln on April 14, 1865. The accounts of the shooting and autopsy are well documented.[2] Mr. Lincoln was shot in the back of the head. At that time 2 army doctors, C. A. Leale and C. S. Taft, endeavored to revive the wounded president with brandy. Later, surgical exploration indicated that the bullet had traveled 7 inches into Mr. Lincoln's brain. Nine hours after he was shot, still unconscious, the president died. The autopsy was described by Doctor Curtis, one of the two army pathologists charged with the postmortem:

> Eleven o'clock comes; the two designated pathologists are ushered into what was the bedchamber of the deceased, a room furnished in simplest style. There sit in solemn silence some officers in uniform and some civilians, while the Surgeon General paces nervously to and fro beside another silent occupant of the chamber, a shrouded figure cold and motionless, lying outstretched upon two boards laid across trestles . . . The shroud is laid back, and see! A smooth clear skin fitting cleanly over well rounded muscles, sinewy and strong . . . Next see at the back of the head, low down and a little to the left, a small rounded blackened wound, such as is made by a pistol shot at close range. There is no counter opening, so the missile has lodged and must be found . . . The part is lifted from its seat, when suddenly, from out a cruel vent that traverses it from end to end, through these very fingers there slips a something hard—slips and falls with a metals' mocking clatter into a basin set beneath. The search is satisfied.

Notwithstanding, the great advances made after the introduction of anesthesia in 1846, elective surgery into the deeper attics of the body was rare. Wound infections took an increasing toll of life and in many cases the inavailability of an adequate means to accurately localize foreign bodies in the tissues impeded surgical approaches

[2]Information on Presidents Lincoln and Garfield was made available through the courtesy of the Medical Museum, Armed Forces Institute of Pathology. Captain W. M. Silliphant, M.C., U.S.N. Director.

that would be, at the present day, lifesaving. The assassination of President James Garfield in 1881 well illustrates these problems. X-rays had not then been discovered and no known means of locating the bullet were available. On two occasions, Professor Alexander Bell endeavored to locate its exact position with an electrical device called an "induction balance" but without success. In the absence of blood transfusions and chemotherapeutic and antibiotic drugs, surgery could not be performed on the president. The fatal shot had entered Mr. Garfield's back about 4 inches to the right of his spinal column and then traveled 9 inches in a diagonal and downward direction, fracturing the eleventh and twelfth ribs on the right and passing through the first lumbar vertebra, missing the cord. Grazing the splenic artery, the bullet finally stopped behind the pancreas. Probing of the wound was unsuccessful, soft tissues blocking the advance of the probe after some 3 inches. Although the initial hemorrhage was controlled, the wound began soon to discharge pus. Developing a generalized infection, he died 2 months later. With modern surgery such a wound would rarely be fatal.

GUNSHOT WOUNDS IN THE TWENTIETH CENTURY

Although the observations of both Pasteur and Lister in reference to antiseptic surgery served as the trumpet of a prophecy that was to revolutionize twentieth century surgery progress remained slow. The upheaval of World War I was little prepared for the surgical treatment of the wounded. Gas gangrene, "the death that stalked the battlefield," brought tragic mortality in its wake and the apathy of medical philosophy in practicing the principle of "let alone" served only to add to the misery of war. Bacteriology was a new science and in part skeptically received. Of the European surgeons, perhaps those in France succeeded best in laying the groundwork for a higher standard of treatment. The introduction of débridement of wounds and the use of drains and rubber tubes to irrigate the deeper tissues constituted a successful beginning to the control of wound infection. The success of Winnett Orr in incasing fractures in plaster became later the standard treatment for osteomyelitis, but by and large wound infections were of the most serious consequence. Contemporaneously, as nations, particularly America, became increasingly industrialized the pathologic processes of wound trauma became of importance to civil as well as to military surgeons. The most dramatic progress of the century was made in the late 1930's during the Spanish Civil War. By treating wounds by open therapy—a method he had previously advocated and applied to industrial accidents—Trueta succeeded in reducing mortality from gas gangrene to a negligible percentage. In contrast to the days of Paré, 96 per cent of the wounded could now be saved. In later years, in World War II, the British Army pursued these studies in the Libyan and Egyptian Campaigns. These investigations revealed that military personnel carried the clostridia with them in their uniforms thereby explaining the apparent ubiquity in all climates and regions for the anaerobic agents of infection. The practice of opening wounds widely and removing dead and necrotic tissue followed by secondary closure at a later date has revolutionized the treatment of civilian, traumatic, and accident surgery. The advent of x-rays, antibiotic and chemotherapeutic drugs, as well as the understanding of the dynamics and changes in tissues subject to gunshot trauma have now greatly prolonged survival time. Insight into these injuries has been excellently presented in the experimental ballistic studies of Kocher, Horsley, Sillipahant, Holmes, and Enos, among others.

Specialized branches of surgery, plastic and reconstructive repair, vascular surgery, and the development of prosthetic limbs and appendages have grown with the increase of power and destructive potential of modern weapons. As the result of studies made in war and in combat, disruption of the circulation, shock, septic inflammation, and the extravasation of blood into the tissue spaces are better comprehended. From a therapeutic viewpoint, fluid replacement, blood transfusion, and emergency operating units are now part of a surgical service. Perhaps above all, the modern surgeon works in harmony with the physician, and the words of Richard Carmicheal, three times President of the Royal College of Surgeons in Ireland, written in 1841 bid fitly: "It is certain that there cannot be a good physician who has not the knowledge of a surgeon, or a good surgeon who has not the knowledge of a physician; therefore, it is obvious that both, should be educated alike." To this education the area of gunshot wounds has added in the past, and doubtless will in the future, no minor contribution to the remarkable achievements and greater progress of medical science.

Reviews of New Books

THE FOURTH VOLUME of *Cancer*[1] comprises the whole of Part VIII and is listed as the clinical aspects of malignant tumors. In view of the approach one may well substitute surgical for clinical. Certainly, the attitude of the various authors is so directed.

Again, there is close relation to the previous material. Where possible, reference is made to eliminate duplication. This particularly applies to pathologic features, classifications, general aspects, and diagnostic terms.

Binding, printing, and illustrations maintain the same high level of the previous books. The different writers are carefully selected and represent accepted authorities in the respective fields. While most of them are from England, with emphasis on London, there are others from the British Commonwealth and from the United States.

There is a rather uniform style as though an outline of presentation may have been suggested. This does not detract from the subject matter but rather enhances it. Although there is discussion of various operative techniques employed, with emphasis on those preferred by the various writers, nonetheless most comments on this aspect remain generalized. Proper space has been allotted in keeping with the frequency of cancer in the tissues as well as in the organs.

This reviewer particularly enjoyed the opening chapter on the "Staging of Cancer" and recommends it for study and possibly abstracting by all physicians. Following this, there is coverage of the entire body either in regions such as lips, mouth, jaws, pharynx, or organs such as salivary glands, kidney, pancreas, etc.

It is unnecessary to select any one chapter for comment. All are of equal merit and the discussion is thorough. Even rare malignant tumors in the various organs and tissues are mentioned. Remarks are concise, and redundant verbiage is eliminated. Tables, photographs, photomicrographs, charts, and drawings are chosen with care and are always instructive. Cataloging is not emphasized.

Possibly the one phase which might cause differences of opinions among all who are students of cancer and who will read this volume in the set is that concerning treatment. However, progress is made through these logical arguments.

The reviewer reiterates, Volume IV is an excellent text on the clinical aspects of malignant tumors.

—*M. C. Wheelock.*

RADIOTHERAPY has needed a modest sized single volume to serve as an introduction to its important clinical problems, to present a balanced evaluation of its accomplishment, to indicate the incompleteness of some of the data available as a basis for clinical judgment, and yet to present a practical approach to clinical treatment. *Therapeutic Radiology; Rationale, Technique, Results*[2] by William T. Moss goes far to fill this need. Beginning with a chapter which presents general concepts in therapeutic radiology, basic radiobiologic concepts, clinical guides to dosages, and the relation of the therapist to the surgeon, the pathologist, and the physicist, the text lucidly explains the important clinical problems of radiotherapy, covering all neoplastic diseases of major interest to the radiotherapist and some selected benign conditions.

Each discussion of the diseases of an anatomic region or organ is introduced by a summary of the current knowledge of the effects of irradiation on the pertinent normal tissues and organs. These summaries are oriented toward information of immediate or potential value for clinical problems. At present, such information is scattered through a diffuse literature. The author has rendered a valuable service in organizing this material and making it available in conjunction with the clinical aspects of the field. Throughout, the author commendably emphasizes principles and rationale rather than detailed discussion of technical methods; but sufficient discussion of treatment techniques is presented for practical orientation. Rather than writing a section on radiologic physics which is so adequately covered in a number of current texts, the author wisely assumes a knowledge of the subject. The therapeutic application of radioisotopes is developed when pertinent.

This volume is an important addition to the existing texts on radiotherapy and will be particularly valuable to physicians training in the field. The seasoned radiotherapist will find much to interest him and the nonradiotherapist will welcome this clearly written, sound, and sensible discussion of radiotherapy.

—*Isadore Lampe.*

A PRACTICING PHYSICIAN once commented that while he was in medical school textbooks seemed too bulky, too extensive, and more detailed than was necessary. Later in active practice, when he was confronted with actual diagnostic and therapeutic problems the same texts seemed incredibly incomplete as he searched avidly and unsuccessfully for details that the authors had deemed too unimportant for inclusion. Weyrauch's *Surgery of the Prostate*[3] is a text written for the practicing urologist. In its field it is perhaps the most complete, detailed treatise yet written. The author has tried to think of every problem large or small, diagnostic or therapeutic, that might confront the urologist caring for patients with prostatic disease; and he has listed detailed instructions for their solution. His presentation is informal

[1]CANCER. Edited by Ronald W. Raven, O.B.E.(Mil.), T.D., F.R.C.S. Vol. IV. Part VIII—Clinical Aspects. 555 pages, 173 illustrations. $18.00. London: Butterworth & Co. Ltd., 1958.

[2]THERAPEUTIC RADIOLOGY; RATIONALE, TECHNIQUE, RESULTS. By William T. Moss, M.D. Foreword by Lauren V. Ackerman, M.D. 403 pages, 146 illustrations. $12.50. St. Louis: The C. V. Mosby Co., 1959.

[3]SURGERY OF THE PROSTATE. By Henry M. Weyrauch, M.D., F.A.C.S. Illustrated by Halcyon Harris Cowles and Ralph Sweet. 535 pages, 288 illustrations. $15.00. Philadelphia and London: W. B. Saunders Co., 1959.

and frank, the type of unvarnished appraisal and discussion one would expect to hear in the surgeons' dressing room or in a small informal seminar with the resident staff participating.

The first chapters deal with surgical anatomy, surgical pathology, and diagnosis of prostatic obstruction. These subjects are clearly and thoroughly discussed. The fifth chapter, "Indications for Operation," is particularly timely and essential reading for all young urologists who are trying to conduct an honest and ethical practice. When to advise operation on the prostate gland is not always an easy question to answer. Weyrauch has met the issue squarely with sound advice. One paragraph is particularly well stated: "In the final analysis the decision to operate must rest on the probability that the patient's urologic condition, his general well-being and the chances for his safety will be improved by prostatectomy. Always tempering a surgeon's judgment is the realization that occasionally a patient undergoes an elective operation only to develop some complication which renders his condition worse than it was prior to operation."

Chapter 6, entitled "Choice of Operation," has required much thought and appraisal by the author. The result is a fair and forthright evaluation with which no urologist, despite his enthusiasm for any one operation, could take issue.

Chapter 9 is concerned with the general principles of prostatic surgery; and Chapters 10 through 13 each cover one method of prostatic surgery in detail—perineal, suprapubic, retropubic, and transurethral. Particularly useful and educational is the unique manner in which the history and development of each procedure is outlined. For many readers, this will be the first clear panoramic view of the contributions and of the men that through the years developed surgery of the prostate, presented in an orderly and chronologic manner.

Each type of prostatic operation is exhaustively treated. Technique is dealt with in minutest detail, and many procedures and maneuvers are described that will help the operator in overcoming technical difficulties. Especially helpful is the discussion of the care, assembly, and use of the complicated instruments used in transurethral prostatectomy. The many technical problems that arise in their employment are enumerated, and methods of correction are outlined. The problem of entry of irrigating fluid into the circulation with the resultant complications of intravascular hemolysis, hyponatremia, and so on is well evaluated. Additional thoroughness could have been achieved in the discussion of urethral trauma, however, by inclusion of a description of preoperative internal urethrotomy for the purpose of preventing postoperative urethral stricture in patients with urethras of small caliber.

Chapter 14, "Postoperative Care and Treatment of Complications," is comprised of almost 100 pages that will be welcome reading, especially for the younger urologists. In addition to the standard subjects usually treated in a discussion of this kind, the author has drawn liberally on his personal experience to suggest little tricks and maneuvers to prevent as well as to extricate oneself from troublesome situations. An example of this is the detailed description of how to remove a bag catheter when the bag will not deflate.

Surgery of the Prostate is thorough, easy to read, interesting, and important to any surgeon who performs prostatic surgery. —*John L. Emmett.*

THE EXCELLENT TEXTBOOK concerning *Diseases of Metabolism*[4] first appeared in 1942, and always has been a dependable reference for students and practitioners. Garfield G. Duncan, with 22 contributors in this fourth edition, presents the progress in methods of investigations and changing concepts that have ensued in the 7 years since the publication of the third edition. This carefully prepared textbook incorporates new as well as time-honored information in the clinical fields of metabolism. The discussions are complete, easy to read, and include extensive bibliographies which permit further probing of the subject by the interested reader.

Extensive and comprehensive discussions concerning the following subjects are presented: protein, carbohydrate, lipid and mineral metabolism, water balance, vitamins and avitaminosis, obesity, diabetes mellitus, and diseases of the thyroid and kidney. Shorter but complete essays include undernutrition, glycogen storage disease, and idiopathic galactosemia, gout, porphyrin metabolism, diabetes insipidus, spontaneous hypoglycemia, melituria, and juvenile diabetes. The appendix provides height-weight tables, variables by age and sex. The index of 40 pages is excellent and permits ease in finding the desired subject matter.

The detailed methods of diagnosis and treatment as presented in this textbook should make it helpful to the medical student and practitioner alike. This fourth edition should serve a most useful purpose and is worthy of study, both for its excellent coverage of clinical material and for its extensive bibliography.
—*George C. Turnbull.*

THE BRITISH TEXT *Practical Obstetric Problems*[5] emphasizes the art of obstetrics rather than the mechanics which most American books stress. It puts into words many "pearls" we have learned from our seniors in the labor or delivery room but rarely find in a book.

Especially to be commended are the chapters on induction of labor, postpartum collapse, postpartum hemorrhage, and disproportion. The latter contains a good, practical approach to the clinical evaluation of the pelvis. The author is an enthusiast in the use of Kjelland forceps and has written an excellent description of their use in rotations.

A refreshing sense of humor crops up frequently, as for instance when the author remarks that "obstetrician's stress" in prolonged labor is easily more dangerous than the other two types—maternal and fetal.

[4]DISEASES OF METABOLISM; DETAILED METHODS OF DIAGNOSIS AND TREATMENT. Edited by Garfield G. Duncan, M.D. 4th ed. 1104 pages, illustrated. $18.50. Philadelphia and London: W. B. Saunders Co., 1959.

[5]PRACTICAL OBSTETRIC PROBLEMS. By Ian Donald, M.B.E., M.D., B.S.(Lond.); B.A.(Cape Town); M.R.C.S.(Eng.), L.R.C.P.(Lond.); F.R.F.P.S.(Glas.); F.R.C.O.G. 2nd ed. 712 pages, illustrated. $11.00. Chicago: The Year Book Publishers, Inc., 1959.

A few methods of management reflect the more liberal use of hospitalization which is economically feasible to the average patient only under State medicine, i.e., hospitalization for a fortnight before the expected date of delivery of all women having previous cesarean sections.

For the most part, this book concurs with most of the current thinking in American literature. The author still advocates hot intrauterine douches for postpartum hemorrhage, however. As in other British texts labor is considered prolonged only after a period of 36 hours.

Practical Obstetric Problems is interesting and clearly written and is a helpful addition to the library of anyone teaching or practicing obstetrics. It is not intended as a basic textbook for students.

—Charlotte Herman Kerr.

THE BOOK ENTITLED *A Short Practice of Surgery*[6] by Hamilton Bailey and McNeil Love now appears in its eleventh edition, the first edition having been published in 1932. As the authors point out, the addition of 2 new chapters, one concerned with fluid balance and one with radiotherapy, together with important additions to certain of the older chapters, partially accounts for the development of the *Short Practice* into a sizable treatise.

Moreover, the subject material is not confined to the practice of surgery as known in America. The logical extension of the boundaries of surgery gives this book scope and usefulness not found in the standard texts today. Excellent sections dealing with teeth and gums, specific infectious diseases, radiotherapy, diagnostic radiology, endocrine aspects of surgery, and embryology as they apply to surgery add greatly to the completeness of the subject presentation. Contrary to the custom of having a textbook written by many different authorities under the guidance of an editor, the 52 chapters in this volume are written mainly by Bailey and Love with additional chapters by John Charnely, William P. Cleland, and Geoffrey Knight.

The material is presented in textbook form and the subject matter is organized by anatomic divisions. It is well written and beautifully illustrated. Of the 1,697 illustrations, 698 new blocks for this edition have been prepared, while 541 entirely new illustrations have been added. These are extraordinarily good and are well placed in relation to the text. A goodly number of the illustrations are in color which adds much to their effectiveness. A distinguishing feature is the use of unique diagrams, sketches, and line drawings which contribute greatly to the clarity of the exposition in the text. An interesting example is the comparison of the human body to a house in the discussion of the differential diagnosis of acute appendicitis.

This book is not written as a source of reference, a collection of monographs, or a presentation of conflicting viewpoints regarding surgical disease. Rather it is encyclopedic in nature covering practically all disease entities encountered in surgical practice.

[6] A SHORT PRACTICE OF SURGERY. By Hamilton Bailey, F.R.C.S. (Eng.), F.A.C.S., F.I.C.S., F.R.S.E., and McNeil Love, M.S.(Lond.), F.R.C.S.(Eng.), F.A.C.S., F.I.C.S. 11th ed. 1389 pages, 1697 illustrations (285 colored). $18.00. Philadelphia: J. B. Lippincott Co., 1959.

The discussions of each disease are, in general, limited to the author's preference as to theories of pathogenesis, method of treatment, etc. When read by the uninitiated, the stated treatment may give the impression of being complete and foolproof. However, the majority of opinions stated are universally accepted and popular. In specific instances this is not the case. The authors advocate bilateral ligation of the internal jugular vein in the treatment of follicular carcinoma of the thyroid and suggest, in effect, a Mann-Williamson preparation for the correction of postgastrectomy syndromes. By virtue of the fact that the chapters are written by only 5 authors, there is admirable consistency in form, in method of presentation, and in proper proportion of space considering the many subjects which are discussed. Biographic footnotes have been inserted that add greatly to the interest and enjoyment of the reader. They provide an easy and quick review of certain aspects of medical history. While there is no comprehensive bibliography, the short section entitled "Acknowledgments" provides the inquiring reader with a list of the important authors of the included material thus enabling him to consult the original publications with comparative ease.

One notes the absence of chapters devoted to preoperative and postoperative care, shock, and acute abdominal emergencies as such. However, these subjects are treated elsewhere when germane to the discussion. In this era of physiologic surgery, to some the space allotted to fluid balance, shock, and burns may seem unduly limited. Because of the encyclopedic character of this volume, it is unlike the ordinary textbook of surgery and, therefore, not comparable. The text provides a wealth of information and is most desirable for reference work and assigned reading. This work is a welcome addition to the surgical library of student, practitioner, and specialist and carries on the tradition of excellence in medical literature for which Great Britain is noted.

—Henry K. Ransom and George E. Block.

A SYMPOSIUM on abdominal pain by 4 authors, representing both internists and surgeons, is presented in the little volume entitled *The Differential Diagnosis of Abdominal Pain.*[7] All aspects of abdominal pain, its origins, neurophysiology, and diagnosis are discussed. Despite the scope of the subject it appears that the authors have succeeded to a great extent in covering all of the aspects which was their intent.

In arranging a text on diagnosis, one of the first problems to be met is the arrangement of the subject matter, none being satisfactory for all readers. The authors have chosen to present, first, medical diseases, then a chapter on surgical diseases, and chapters on appendicitis and peritonitis, diseases requiring surgery, retroperitoneal causes of pain, and remote disease causing abdominal pain. Such an arrangement results in unavoidable repetition, but this is necessary for the classification to be practical to the clinician.

Proper emphasis is placed on deciding if operation is necessary rather than risking delay to arrive at an exact diagnosis. It is refreshing to note that intestinal

[7] THE DIFFERENTIAL DIAGNOSIS OF ABDOMINAL PAIN. Edited by Sherman M. Mellinkoff, M.D. 443 pages, 29 illustrations. $9.00. New York: McGraw-Hill Book Co., Inc., 1959.

obstructions are differentiated into those of the small bowel and those of the large bowel. This eliminates some of the confusion which results when all types are grouped under a single heading.

One criticism of the text concerns distortion as regards space and emphasis of various diseases. In the attempt to consider every possible cause of pain, some subjects are necessarily given scanty consideration, and others are overemphasized. An example of this would be the few paragraphs written on traumatic causes of pain. Rupture of the spleen is given approximately as much space as pyloric obstruction due to retroperitoneal hematoma. The text could be improved by the use of additional illustrations.

Despite these criticisms, the book is a good one; it covers much subject material and should be well received. The bibliography is good, and the index is excellent. It will be a valuable aid to medical students, house officers, and all those in practice confronted with the differential diagnosis of abdominal pain.

—*William Requarth.*

THE VOLUME *Total Surgical Management*[8] is a recent addition to *Modern Surgical Monographs*. It is devoted particularly to treatment and to the everyday problems in the practice of surgery.

Various sections are concerned with general surgical measures including preoperative, operative, and postoperative care; others with specific operations dealing with specific anatomic and physiologic areas of the body and still others with general problems including the treatment of some of the more common complications.

Much of this book is devoted to information usually only passed from teacher to student in unwritten form, and this constitutes one of its greatest values to the general surgeon, the house officer, and the student. There are chapters which deal with operability, fluid therapy and nutrition, blood replacement and shock, abnormal bleeding, the wound and its management, and order writing. Other chapters are devoted to trauma and burn management, operations on various areas, and anatomic regions of the body. Still other sections deal with the safe use of anesthesia, the trip to surgery and the recovery room, and some common postoperative problems. Of value to the reader will be the chapter on the acute condition of the abdomen and an additional chapter on the preoperative and postoperative care of infants.

Although this book is directed toward the general surgical practitioner, it would certainly be of value to those who wish some detailed information regarding the routine practices on a surgical service. It should be of special value to the resident surgeon and senior house officer.

—*W. Harrison Mehn.*

THE SHORT BOOK on the *Physiology of Cardiac Surgery*[9] by Frank Gollan, which represents the Beaumont Lecture of the Wayne County Medical Society, is divided into 3 chapters; the first of which is on hibernation and induced hypothermia, the second on extracorporeal circulation, and the third on extracorporeal cooling. The book is a condensed description of the extensive studies the author has made in these fields and a review of other pertinent work.

The author, who has for a number of years distinguished himself as a witty and entertaining speaker, shows in this book that he can write as he talks. The book is sprinkled with humor throughout and written in a lively style which makes it a pleasure to read. The reader may occasionally get the impression, however, that in his effort to achieve a clever aphorism or sharp metaphor the author may have deviated slightly from an unbiased presentation. The bibliography is not meant to be complete, but it does include a number of interesting references to earlier works not widely known. The possibility of some inaccuracies in the author's description of other works in the field was brought to light when the reviewer found some of his own work misquoted.

Though the author takes the role of a physiologist not necessarily interested in practical applications of his methods, the book is certainly directed toward practical applications and it provides useful advice for the surgeon interested in open heart surgery. Gollan favors a system of extracorporeal oxygenation supplemented by judicious cooling and he musters a good argument to support this system. —*F. John Lewis.*

ORTHOPEDICS has evolved into the specialty of musculoskeletal surgery. Many changes have occurred since the days of the "brace and buckle." The problems managed by the orthopedist have changed. The concern is now with the management of trauma and congenital defects than with the residuals of poliomyelitis and infectious disease. With these tenets in mind, Samuel Turek has done an excellent job in organizing *Orthopaedics; Principles and Their Application*[10] dealing with the changing problems.

He has divided the book into four parts. Part 1 deals with the basic sciences, which concerns the structure and function of bone. The statements are clear and to the point. Some, however, may be in the process of becoming outmoded because of the rapid development in the field of bone physiology.

In Part 2, entitled General Orthopaedic Conditions, the metabolic diseases of bone, infections, and tumors are presented. In this section, to familiarize the orthopedist with peripheral vascular disease and neurology, there is a fine review of the diseases of those fields likely to be encountered by the orthopedic surgeon.

Part 3, Regional Orthopaedic Conditions, covers many of the traumatic lesions of bone without actually including fractures. The sections on the shoulder are thoroughly reported upon and are well illustrated.

Part 4 is devoted to Special Subjects, wherein there are two subheadings. In the first, Radioactive Isotopes in Orthopaedics, the author discusses some of

[8] MODERN SURGICAL MONOGRAPHS. Editor in Chief: I. S. Ravdin, M.D. Consulting Editor: Richard H. Orr, M.D. TOTAL SURGICAL MANAGEMENT. By James D. Hardy, M.S., M.D., F.A.C.S. 292 pages, 50 illustrations. $9.50. New York and London: Grune & Stratton, Inc., 1959.

[9] PHYSIOLOGY OF CARDIAC SURGERY; HYPOTHERMIA, EXTRACORPOREAL CIRCULATION AND EXTRACORPOREAL COOLING. By Frank Gollan, M.D. 96 pages, 18 illustrations. $4.50. Springfield, Ill.: Charles C Thomas, 1959.

[10] ORTHOPAEDICS; PRINCIPLES AND THEIR APPLICATION. By Samuel L. Turek, M.D. 906 pages, 600 illustrations, including 53 plates in color. $22.50. Philadelphia and Montreal: J. B. Lippincott Co., 1959.

the principles involved in using isotopes in research and diagnosis of disease. Whereas this is of interest, it has little direct bearing upon the current practice of orthopedic surgery. In the second, Amputations, the subject is routinely presented.

Turek is to be congratulated for the excellent choice of illustrations many of which are taken from the basic source articles. The index is detailed and complete, and the bibliography is conveniently arranged so that references are given at the bottom of the page.

This book is an excellent reference and text which all residents in orthopedic surgery should find of great value. The expense of the book would preclude it being recommended for medical students, but it should be in every hospital and medical school library. The practicing orthopedic surgeon will find it a valuable source for quick reference.

—*Alexander Garcia, Jr.*

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgement must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

Die Sterilitat der Frau; ein Leitfaden der Diagnostik und Therapie fuer die Praxis. By Prof. Dr. Werner Bickenbach and Dr. Gerd K. Doring. 71 pages, 15 illustrations. Stuttgart: Georg Thieme Verlag, 1959.

Atlas of Roentgenographic Measurement. By Lee B. Lusted and Theodore E. Keats, M.D. 176 pages, 119 illustrations. $9.00. Chicago: The Year Book Publishers, Inc., 1959.

Diabetic Manual. By Elliott P. Joslin, M.D., Sc.D. 10th ed. 304 pages, 40 illustrations. $3.75. Philadelphia: Lea & Febiger, 1959.

Office Orthopedics. By Lewis Cozen, M.D., F.A.C.S. 3rd ed. 430 pages, 321 illustrations. $9.50. Philadelphia: Lea & Febiger, 1959.

A Mount Sinai Hospital Monograph. Systemic Lupus Erythematosus. Edited by George Baehr, M.D., and Paul Klemperer, M.D. 84 pages, illustrated. $3.75. New York and London: Grune & Stratton, Inc., 1959.

Roentgendiagnostik des Magen-Darmkanals. By Prof. Dr. R. Prévôt, and Priv.-Doz. Dr. M. A. Lassrich. 346 pages, 544 illustrations. $18.30. Stuttgart: Georg Thieme Verlag, 1959.

Intern's Manual (Cook County Hospital). By Arthur Bernstein, M.D. 2nd ed. 308 pages, illustrated. $3.00. Chicago: The Year Book Publishers, Inc., 1959.

Handbook on Standard Nomenclature of Diseases and Operations. Edited by Edward T. Thompson, M.D., and Adaline C. Hayden, C.R.L. Prepared for American Medical Association. 71 pages. $1.50. New York, Toronto, and London: The Blakiston Division, McGraw-Hill Book Co., Inc., 1959.

The Physiology of the Newborn Infant. By Clement A. Smith, M.D. 3rd ed. 497 pages, illustrated. $12.50. Springfield, Ill.: Charles C Thomas, 1959.

Dictionary of Medical Slang and Related Esoteric Expressions. By J. E. Schmidt, M.D. 207 pages. $6.75. Springfield, Ill.: Charles C Thomas, 1959.

Traumatismes anciens rachis membre inférieur. By R. Merle d'Aubigné, and J. -O Ramadier. With the collaboration of others. 546 pages, illustrated. 8.500 fr. Paris: Masson et Cie, 1959.

Principles of Disability Evaluation. By Wilmer Cauthorn Smith, M.D. 210 pages. $7.00. Philadelphia and Montreal: J. B. Lippincott Co., 1959.

Anesthesia for Infants and Children. By Robert M. Smith, M.D. Foreword by Robert E. Gross, M.D. 418 pages, 182 illustrations. $12.00. St. Louis: The C. V. Mosby Co., 1959.

Dringliche Chirurgie beim Säugling und Kind. By Doz. Dr. Dr. H. -E. Grewe. 189 pages, 60 illustrations. $5.95. Stuttgart: Georg Thieme Verlag, 1959.

Surgical Service Guide. By Louis T. Palumbo, M.D., F.A.C.S. 208 pages, illustrated. $6.00. Chicago: The Year Book Publishers, Inc., 1959.

El medio interno en cirugia. By Gualterio Cristiani. 164 pages, illustrated. Buenos Aires: Editorial Vergara, 1959.

The Care of Minor Hand Injuries. By Adrian E. Flatt, M.D., F.R.C.S. Foreword by Carroll B. Larson, M.D. 266 pages, illustrated. $9.50. St. Louis: The C. V. Mosby Co., 1959.

Handbook of Physiology; A Critical, Comprehensive Presentation of Physiological Knowledge and Concepts. Section 1: Neurophysiology, Vol. I. Editor-in-Chief: John Field. Section Editor: H. W. Magoun. Executive Editor: Victor E. Hall. Washington, D. C.: American Physiological Society, 1959. Baltimore: The Williams & Wilkins Co., exclusive U. S. agents.

The Kinetics of Cellular Proliferation. Edited by Frederick Stohlman, Jr., M.D. 456 pages, illustrated. $5.75. New York and London: Grune & Stratton, Inc., 1959.

Röntgendiagnostik beim Neugeborenen und Säugling. By Hermann G. Wolf. Foreword by Prof. Dr. K. Kundratitz. 317 pages, 370 illustrations. $23.60. Wien: Verlag Wilhelm Maudrich, 1959.

L'arteriopatia ostruttiva aorto-iliaca; motivi clinici, spunti patogenetici. By Ennio Muntoni. With the collaboration of J. Del Moro, R. Liscia, and F. Pizzetti. Preface by Pietro Valdoni. Supplemento N. XV al Giornale de Gerontologia. 185 pages, 84 illustrations (16 in color). L. 3500. Giornale de Gerontologia.

Die Bewegungsbestrahlung. By Prof. Dr. F. Wachsmann and Prof. Dr. Dr. G. Barth. 2nd ed. 200 pages, 150 illustrations. $10.95. Stuttgart: Georg Thieme Verlag, 1959.

The Year Book of Cancer (1958–1959 Year Book Series). Compiled and edited by Randolph Lee Clark, Jr., M.D., M.Sc.(Surg.), D.Sc.(Hon.), and Russel W. Cumley, B.A., M.A., Ph.D. 570 pages, 202 illustrations. $8.00. Chicago: The Year Book Publishers, Inc., 1959.

Mitral Valvulotomy. By Harold J. Stewart, M.D., and Frank Glenn, M.D. 244 pages, 25 illustrations. $10.50. Springfield, Ill.: Charles C Thomas, 1959.

Pediatric Neurosurgery. Edited by Ira J. Jackson, M.D., F.A.C.S., F.A.C.A., and Raymond K. Thompson, M.D., F.A.C.S. 564 pages, illustrated. $16.50. Springfield, Ill.: Charles C Thomas, 1959.

Fundamentals of Gynecology. By Samuel J. Behrman, M.D., Ch.B., M.S., M.R.C.O.G.(Lond.), F.A.C.S., and John R. G. Gosling, M.D. 416 pages, 166 illustrations. $9.50. New York: Oxford University Press, 1959.